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ABOUT THE PROGRESS JOURNALS

‘The Progress Journals’ is a flagship initiative of The Progress, which belongs to one of the verticals of Sri Aurobindo Yoga & Knowledge Foundation with a mission of Sustainable & Holistic Development. Begun in 2023, the vision behind this publication is to create an international, cross-disciplinary, peer-reviewed and open-access journal that deals with issues of social, cultural, economic and ecological importance. This bilingual journal (with papers in English and Hindi) seeks to provide a platform for people engaged in innovative studies on subjects related to sustainability and sustainable development.

The journal also aims to highlight the significance of the Sustainable Development Goals (SDGs), also known as the Global Goals, which were set up by the United Nations in 2015. These goals were designed to be a "blueprint to achieve a better and more sustainable future for all." They comprise a universal call to action to promote individual and social well-being on a global scale. The 17 SDGs are (1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (10) Reducing Inequality, (11) Sustainable Cities and Communities, (12) Responsible Consumption and Production, (13) Climate Action, (14) Life Below Water, (15) Life On Land, (16) Peace, Justice, and Strong Institutions, (17) Partnerships for the Goals.

This journal, which shall be published quarterly, will allow researchers from various backgrounds to share their opinions and findings on topics related to these goals. Through this exchange of knowledge, we hope to better understand how to implement these principles for the development of our communities, our nation and the world.

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²Professor, Department Of Mathematics,
Anjaneya University

³Professor, Department Of Mathematics,
Anjaneya University

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¹Associate Professor and Head, Department of Chemistry,
L.B.S. Govt. P.G. College, Halduchaur, Nainital, India

²Assistant Professor, Department of Mathematics, L.B.S. Govt.
P.G. College, Halduchaur, Nainital, India

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Maharaja Agrasen International college, Raipur

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¹Research Scholar, Department of Business Administration,
Cauvery College for Women (Autonomous),
affiliated to Bharathidasan University, Tiruhirappalli

²Research Supervisor, Department of Business Administration,
Cauvery College for Women (Autonomous),
affiliated to Bharathidasan University, Tiruhirappalli

³Co-Supervisor, Department of Management Studies,
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सह-प्राध्यापक, केन्द्रीय संस्कृत विश्वविद्यालय, जयपुर परिसर,
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Maharaja Agrasen International College,
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EDITOR'S NOTE

THE PROGRESS, established in 2020, is one of four recent initiatives of Sri Aurobindo Yoga and Knowledge Foundation. The core objective of our organization is the transformation of consciousness in higher education. The inspiration for this goal is the philosophy of Sri Aurobindo and the Mother, especially the principles of Integral Yoga. We believe that true progress requires consciousness of one's role in one's family, community, nation and the world. We seek to create this distinctive awareness, especially among students, professors, researchers and other key stakeholders in the field of education. At present, we are associated with more than 28 higher education institutions, including IIT Delhi.

In Integral Yoga, it is written that there are five layers of the mind: Physical, Vital, Mental, Psychic, and Spiritual. In higher education institutes today, the teaching-learning process is such that it functions till the Vital layer. There is no formal curriculum for anything beyond that. That kind of learning only comes through community, social and spiritual initiatives. Most higher education institutions have already started different types of developmental projects, social work, etc. Our objective is to create an organization that can connect all these other institutions and then collectively, we can be a force for universal transformation. To the broad vision of progress, we each bring our own unique perspective. Together, we can refine our approach and make a difference globally, while being rooted in our regional heritage.

In 2023, we launched a new initiative, 'The Progress Journals' with a mission to highlight scholarly work on Sustainable Development in general and the significance of the Sustainable Development Goals (SDGs) proposed by the UN, specifically. This is our first issue and we are very grateful to all our contributors and supporters. We aim to release this bilingual journal on a quarterly basis and provide a space for new voices and fresh perspectives.

- *Dr. Samarendra Mohan Ghosh*
Editor-in-Chief



Post Quantum Cryptography Mechanisms for Enhancing Security in Government Healthcare Systems

Shanu Shrivastava¹

Research Scholar, Department Of Mathematics, Anjaneya University

Prof. C Ramesh Kumar²

Professor, Department Of Mathematics, Anjaneya University

Prof. Manju Sanghi³

Professor, Department Of Mathematics, Anjaneya University

Abstract

Government healthcare systems manage massive volumes of sensitive patient data across hospitals, primary care centers, and national health schemes. Digitization initiatives such as electronic health records (EHRs), telemedicine platforms, and wearable medical devices have improved access to healthcare but have simultaneously exposed public health data to cybersecurity threats. Classical cryptographic algorithms like RSA and ECC are increasingly vulnerable due to the rise of quantum computing. Post-Quantum Cryptography (PQC) provides algorithms resistant to quantum attacks, ensuring confidentiality, integrity, and authenticity of patient information. This paper examines the applicability of PQC in government healthcare systems, evaluates different quantum-resistant algorithms, and proposes an adoption framework for large-scale national health networks. Using literature review, simulation experiments, and expert consultation, this study concludes that lattice-based algorithms such as Kyber and Dilithium are optimal for real-time government health data, while hash-based schemes such as SPHINCS+ are ideal for archival systems. Implementation challenges, policy implications, and a roadmap for nationwide deployment are discussed, highlighting a future-ready approach to secure public healthcare infrastructures.

Keywords: *Post-Quantum Cryptography, Healthcare Security, Lattice-Based Cryptography, Hash-Based Signatures, Electronic Health Records (EHR), Telemedicine Security, Quantum Computing Threats*

1. Introduction

Government healthcare systems are tasked with providing universal, affordable, and efficient medical care. Initiatives like Ayushman Bharat Digital Mission (ABDM) aim to digitize health records and integrate hospitals, clinics, and

telemedicine services across India. National health databases store sensitive information including patient demographics, clinical history, lab results, and insurance details. While digitization increases accessibility and efficiency, it also exposes public healthcare data to cyber

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threats, including ransomware, data breaches, and identity theft (Ponemon Institute, 2021).

Traditional cryptographic methods such as RSA and ECC secure communications and storage, but are vulnerable to quantum computing attacks. Shor's algorithm can break RSA/ECC, while Grover's algorithm reduces the security of symmetric encryption (Shor, 1994; Grover, 1996). This is particularly concerning for government systems where millions of patient records are stored and shared across various departments and cloud infrastructure.

Post-Quantum Cryptography (PQC) offers algorithms resistant to quantum attacks. Adopting PQC ensures long-term security, compliance with health data regulations, and trust in national health programs. This paper explores PQC implementation in government healthcare, evaluates algorithm performance, and outlines a framework for large-scale deployment in public health systems.

Government initiatives such as the Ayushman Bharat Digital Mission (ABDM) emphasize secure and interoperable digital health ecosystems. Integrating Post-Quantum Cryptography aligns with national digital health policies by ensuring long-term data protection, regulatory compliance, and resilience against emerging quantum threats in public healthcare infrastructure.

2. Literature Survey

The NIST PQC standardization project evaluates quantum-resistant algorithms suitable for large-scale deployment (NIST, 2022). Lattice-based schemes like Kyber

and Dilithium are widely recommended due to their efficiency and scalability (Alkim et al., 2016). Hash-based schemes like SPHINCS+ provide long-term integrity, making them suitable for archival systems (Buchmann et al., 2011). Code-based (McEliece) and multivariate schemes (Rainbow) offer additional security for regulatory compliance, though they require higher computational resources.

Government-focused studies highlight vulnerabilities in EHR systems, telemedicine platforms, and IoT-based public health monitoring devices (Hussain et al., 2022). While private sector healthcare has started adopting PQC pilots, national healthcare frameworks require additional research to ensure scalability, interoperability, and compliance with government regulations (Duong et al., 2023).

3. Research Objectives

- Evaluate quantum-resistant algorithms for government health data systems, telemedicine, and IoT medical devices.
- Analyze performance trade-offs in encryption speed, computational cost, and key storage requirements.
- Identify challenges in integrating PQC with legacy government IT infrastructure.
- Propose a nationwide PQC adoption roadmap for hospitals, primary health centers, and telemedicine networks.
- Assess PQC's impact on compliance with national health

data policies, privacy regulations, and patient trust.

4. Hypothesis

- Null Hypothesis (H₀): PQC does not significantly improve the security of government healthcare systems.
- Alternative Hypothesis (H₁): PQC mechanisms significantly enhance security, ensuring confidentiality, integrity, and compliance against quantum-enabled attacks.

5. Research Methodology

- Literature Review: Analysis of NIST PQC reports, IEEE papers, and government healthcare cybersecurity frameworks.
- Simulation Tools Used:
 - Python (NumPy, Cryptography libraries)
 - OpenSSL (for cryptographic benchmarking)
 - MATLAB (performance analysis)
 - NS3 Simulator (network simulation for healthcare data transmission)
- Datasets: Simulated datasets representing EHRs, IoT medical sensor data, and telemedicine logs
- Metrics Evaluated: Encryption time, decryption time, key size, latency, computational overhead
- Expert Consultation: Interviews with healthcare IT administrators and cybersecurity professionals

This mixed-method approach ensures both technical rigor and practical applicability in government health systems.

6. Post-Quantum Cryptography in Government Healthcare

Lattice-Based Cryptography

- Algorithms: Kyber (encryption), Dilithium (digital signatures).
- Security: Resistant to quantum attacks, moderate key size, suitable for real-time data.
- Use-Cases: EHR encryption, secure telemedicine communication, IoT-based remote monitoring.

Hash-Based Cryptography

- Algorithm: SPHINCS+.
- Security: Long-term integrity, tamper-proof signatures.
- Use-Cases: Archival patient records, long-term government health data storage.

Code-Based and Multivariate Cryptography

- Algorithms: McEliece (code-based), Rainbow (multivariate).
- Security: Strong theoretical security for regulatory compliance.
- Limitation: Large key sizes and computational cost restrict real-time use.

7. Data Analysis for Government Deployment

Algorithm Type	Security Level	Key Size	Computational Cost	Suitable Government Use-Case
RSA (3072-bit)	Classical	Large	Moderate	Legacy hospital systems

Algorithm Type	Security Level	Key Size	Computational Cost	Suitable Government Use-Case
ECC (256-bit)	Classical	Moderate	Low	Telemedicine & mobile apps
Kyber (Lattice-Based)	Quantum-Resistant	Moderate-Large	Moderate	National EHR & IoT networks
Dilithium (Lattice-Based)	Quantum-Resistant	Moderate	High	Digital signatures for prescriptions and lab reports
SPHINCS+ (Hash-Based)	Quantum-Resistant	Very Large	High	Archival health records & compliance data

Observation: Lattice-based schemes are most feasible for real-time national healthcare operations, while hash-based schemes are optimal for archival data integrity.

Comparative Interpretation

The analysis indicates that lattice-based algorithms such as Kyber provide an optimal balance between security and performance, making them suitable for real-time healthcare applications. Dilithium ensures strong authentication through digital signatures but introduces higher computational overhead. Hash-based schemes like SPHINCS+ offer superior long-term integrity, making them ideal for archival healthcare records despite larger key sizes. Classical algorithms like RSA and ECC, although efficient, are not suitable for future quantum-secure healthcare systems.

8. Implementation Challenges

- Limited computational resources in rural healthcare centers
- High cost of upgrading legacy hospital IT infrastructure
- Bandwidth limitations in telemedicine networks
- Storage overhead due to large PQC key sizes
- Lack of trained cybersecurity professionals in public healthcare
- Integration challenges with existing EHR systems
- Regulatory and compliance adaptation delays

9. Proposed Framework for Government PQC Adoption

1. Assessment Phase: Evaluate existing IT infrastructure and identify vulnerable points.
2. Pilot Deployment: Implement PQC in selected regional hospitals and telemedicine platforms.
3. Hybrid Model: Integrate PQC with classical cryptography to ensure smooth transition.
4. Training & Policy Development: Staff training, SOPs, and compliance guidelines.
5. National Rollout: Gradual implementation across all government hospitals, health centers, and telemedicine networks.
6. Monitoring & Maintenance: Real-time monitoring of encryption systems, automated key rotation, and incident response protocols.

10. Future Scope of Work

Nationwide Hybrid Cryptography Models

- Combine classical and PQC for smooth migration across government hospitals and health IT systems.

Optimization for IoT Medical Devices

- Lightweight PQC algorithms for wearable government health monitoring devices, telemedicine kits, and remote diagnostic tools.

AI-Assisted Key Management

- Automate key generation, rotation, and validation using AI across national networks.

Standardization & Policy Compliance

- Develop PQC standards for government hospitals compliant with national digital health policies.

Long-Term Data Archival Security

- Use hash-based schemes for decades-long retention of public health records.

Integration with Emerging Tech

- PQC with blockchain for secure sharing between hospitals, labs, and health insurance authorities.
- Edge computing for real-time encryption at medical IoT endpoints.

Nationwide Performance Monitoring

- Develop dashboards and audit systems for encryption efficiency,

key management, and security breaches.

Table: Government Future Scope Summary

Area	Description	Benefits	Research Focus
Hybrid Cryptography	Classical + PQC	Smooth nationwide deployment	Migration strategies, performance optimization
IoT Devices	Lightweight PQC	Efficient & fast	Kyber-Lite optimization
AI Key Mgmt	Automated monitoring	Reduced errors, scalable	AI/ML-based key management
Standardization	Policy compliance	Regulatory adherence	National PQC framework
Data Archival	SPHINCS+ optimization	Long-term integrity	Hybrid archival solutions
Emerging Tech	Blockchain & edge computing	Secure data sharing	AI-PQC integration
Nationwide Monitoring	Dashboards & audit systems	Transparency & accountability	System performance & security metrics

11. Conclusion

This study demonstrates that Post-Quantum Cryptography significantly enhances the security of government healthcare systems against future quantum threats. Lattice-based algorithms such as Kyber and Dilithium are suitable for real-time healthcare applications, while SPHINCS+ ensures long-term archival security. The proposed hybrid implementation model enables a smooth transition from classical cryptography to PQC.

The findings suggest that nationwide deployment of PQC can improve data

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confidentiality, strengthen regulatory compliance, and enhance patient trust. A phased implementation strategy involving pilot testing, infrastructure upgrades, and policy alignment is recommended for successful adoption.

12. Implications

- Strengthens national healthcare cybersecurity.
- Ensures compliance with national digital health policies.
- Enables trustworthy telemedicine services.
- Protects government health databases against future quantum attacks.

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Indigenous Knowledge: An Analysis of the Sun in Indian Culture

Dr. Bipin Chandra Joshi¹

Associate Professor and Head, Department of Chemistry, L.B.S. Govt. P.G. College, Halduchaur, Nainital, India, E-mail: drbipinchem@gmail.com

Dr. Poonam Miyan²

Assistant Professor, Department of Mathematics, L.B.S. Govt. P.G. College, Halduchaur, Nainital, India, E-mail: pooares4u@gmail.com

Abstract:

India made significant advancements in indigenous knowledge during the ancient and medieval periods. The Indian Knowledge System (IKS) encompasses the practices, expressions, insights, understandings, beliefs, and experiences of Indigenous groups developed over centuries of profound interactions with a particular territory. The intellectual achievements of Indian thought are found across several fields of study in the Vedas and Upanishads, to a wide range of scientific, technical, scriptural, philosophical, and artistic sources. Sun worship is vital in Vedic worship in the form of gods, such as Surya, Martanda, Usa, Pusan, and Rudra. The sun is regarded as a vital source of life and energy, playing a central role in many Indigenous cultures. It is associated with deities, creation stories and ceremonies. In Hinduism, people observe the sun to understand its connection with local topography and weather. Many Indigenous cultures have unique perspectives on solar and lunar eclipses, often viewing them as powerful events with spiritual or symbolic significance to their people. Indigenous knowledge of the sun is passed down through oral traditions, stories, songs, and ceremonies.

This study analyses the indigenous knowledge of the sun in the Indian knowledge system. This knowledge spans various aspects, from observing the sun's movement and its impact on the seasons and weather to its role in religious and spiritual practices in the region.

Key-words: *Indigenous knowledge, Indian Knowledge System (IKS), scriptural, philosophical, and traditional knowledge.*

Introduction:

Indian culture and traditions have made extraordinary contributions to science and spirituality since ancient times. Traditional and indigenous knowledge is a collective form of awareness and understanding of the

behaviors and beliefs of local people, passed down through generations by social transmission. The applications and importance of indigenous knowledge can be experienced through the customs and rituals celebrated across India. Traditional knowledge is a part of the cultural identity

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of Indigenous and local peoples. Indigenous knowledge in India encompasses a vast repository of cosmological, astronomical, philosophical, and spiritual insights passed down through generations. Indigenous knowledge systems are community-based, experiential, and holistic, encompassing practical and symbolic relationships with the environment. The sun has held a central position in Indian culture for millennia, revered as a celestial body and divine and life-giving force. The sun's great impact has long been observed by the masses. According to modern astronomy, the Earth's orbit around the Sun is not a perfect circle but a slightly elliptical path that varies in distance from the Sun. Because of this elliptical orbit, the distance between the Earth and the Sun changes slightly throughout the year. At its closest point to the Sun, known as the perihelion, the Earth is approximately 91,445,000 miles (147,166,462 km) from it. At its farthest point, called the aphelion, the Earth is approximately 94,555,000 miles (152,171,522 km) away, occurring around July 3 each year. The average distance between the Earth and the Sun is approximately 92,955,807 miles (149,597,870.691 km). The first scientific measurement of this distance was made in 1672 by Jean Richer and Giovanni Domenico Cassini, who estimated it to be 22,000 times the radius of Earth. Given the Earth's radius as 6,371 km, their calculation was $22,000 \times 6,371 = 140,162,000$ km—about 140 million kilometres.

The inclusion of Indigenous knowledge regarding the sun may enrich modern society's knowledge base. This study

explores Indigenous knowledge of the Sun in Indian culture and spiritual practices.

Methodology:

This study is based on secondary data collected from different published secondary sources, such as research papers, articles, Upanishads, religious books, and annual reports.

The Sun as a Deity:

➤ The Hanuman Chalisa Connection:

Interestingly, two lines from the Hindu devotional hymn Hanuman Chalisa, composed by Goswami Tulsidas in the 16th century, appear to describe this distance:

जुगसहस्रयोजनपरभानु,
लील्योताहिमधुरफलजानू

juga-sahasra-yojana-parabhānu, līlyotā hi
madhura-phalajānu

The phrase “जुगसहस्रयोजनपरभानु” (juga-sahasra-yojana-para-bhānu) translates to—“The Sun (bhānu) is at a distance of yuga-sahasra-yojanas.”



Fig 1: Hanuman Chalisa

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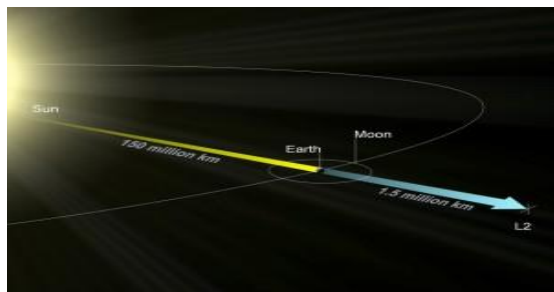


Fig 2: Distance between Sun and Earth

According to traditional Hindu measurements in Vedic literature found in ancient texts:

1 Yuga	A divine era	12,000 (used here as a numerical value)
1 Sahasra	A thousand	1,000
1 Yojana	A measure of distance	8 miles

Therefore:

Yuga × Sahasra × Yojana = Para Bhanu
(distance to the Sun)
12,000 × 1,000 × 8 miles = 96,000,000 miles
Conversion of miles to kilometers
96,000,000 × 1.6 = 153,600,000 kilometres

A Remarkable Comparison

Modern (average)	149,597,870 km
Hanuman Chalisa (interpreted)	153,600,000 km

Cassini and Richer (1672)	140,162,000 km
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The value derived from the Hanuman Chalisa differs from the modern scientifically accepted distance by only approximately 3%, which is remarkably close to the text composed centuries before the invention of modern instruments.

Owing to the importance of the Sun, the Vedic Aryans deified and personified the force of nature, which consists of heat and light, and worshipped it as a deity, praising its various aspects. The importance of the sun is noted by Katyayana in the Sarvanukramani as follows:

एकैव वा महानात्मा स तत् सूर्य इत्यचक्षते ॥
ekaivava mahanatma a tat surya ityacaksate
There is one great god, Surya. In Brhaddevata, Saunaka directs the Sun to be the very soul of all other gods. In the Rigvedic section
इन्द्रं मित्रं वरुणमग्निम् ॥
indram mitram varunamagnim,

It is stated that Indra, Mitra, Varuna, and Agni are the names of the same divine being, the one Supreme Spirit and universal force, under various indications. Surya is the direct embodiment of the atmospheric Sun. This is the most clearly conceived and defined form of solar divinity in the Rig Veda. Day and night are created by the sun's rising and setting. As the creator of day and night, it provides heat and light to the entire universe and food and vegetation to all living beings. Different aspects and positions of the Sun have given rise to

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independent Sun-gods in Vedic literature; thus, a group of solar divinities was formed in Vedic literature.

➤ Surya in Vedic Tradition:



Fig 3: People of India worshipping the Sun God

In the Indian Knowledge System (IKS), which integrates philosophy, spirituality, science, and daily life, the sun is understood not only as a star in the sky, but also as a life-giving force, deity, and cosmic regulator. In the Hindu pantheon, the Sun and Moon are the only deities that can be seen with the naked eye. The Vedas are not only sacred or religious texts but also a source of knowledge. This literature is a source of pride for the country. In addition, the customs and rituals passed down from our ancestors are effective methods devised by our great sages to transmit this knowledge to future generations. Surya is one of the principal deities in the Rigveda. Surya is portrayed as the eye of the universe (*Chakshu Surya*) and the sustainer of all life.

Rituals and practices involving the sun:

Spirituality is the soul of Indian culture and the science of the 'life-giving substance.' Surya represents truth, order (*ṛta*), and knowledge. The Sun's movement is closely

linked to rituals and the seasonal cycles. In Indian traditional medicine, practices such as Surya Jal (solarised water) and Atapasevana (controlled sun exposure) are prescribed for health and balance. A daily Vedic ritual is performed at sunrise and sunset, emphasising the alignment with solar rhythms. It is a major festival in parts of North India, in which devotees offer prayers to the rising and setting sun, highlighting their gratitude for life and fertility. The atmosphere created during the celebration purifies society. The Yoga philosophy, as propounded by sage Patanjali, attaches great prominence to Sūryanamaskāra. Sūryanamaskāra is a yogic practice that symbolizes reverence to the Sun, combining physical postures with spiritual reflection. It is an ancient exercise aimed at achieving physical and mental equilibrium of human beings. Sūryanamaskāra is performed before sunrise and after sunset. It is a yogic sequence of 12 postures aligned with the Sun's movements that integrates physical health, breath regulation and spiritual reverence. Surya Namaskar practices are now gaining global recognition for their benefits to physical and mental health.



Fig 4: Steps of Surya Namaskar

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Solar Knowledge in Indigenous Calendrical Systems:

A Vedic calendar based on the sun, known as the Saura Maanam, is a solar calendar that follows the apparent movement of the sun around the Earth to mark seasons and months. Unlike the lunar calendar, which is determined by the phases of the moon, Saura Maanam relies on the sun's position in the zodiac. It forms an essential part of the Hindu calendar system, which harmoniously combines both solar and lunar elements to organise time and rituals by adding *adhik-maas* every two to three years. The concept of *Adhik Maas* is unique to the traditional Hindu calendar. For example, in the 2023 calendar, there were 13 months with an *Adhik-Maas* between July 18 and August 16. The Hindu calendar continues to shift slowly with respect to the seasons because of the precession of the Earth's axis.

➤ Year, Month, and Day:

द्वादश प्रथयश्चक्रमेकं त्रीणि नभ्यानि क उ तच्चिके
ता | तस्मिन्साकं त्रिशता न शंकवोऽर्पिता षष्टिर्न च
लाचलासः॥

dvādaśa pradhayaś cakram ekaṃ trīṇi
nabhyāni ka u tac ciketa | tasmin sākam
triśatā na śaṅkavo 'rpitā ṣaṣṭir na calācalāsaḥ
॥

The chariot of the Sun has 12 *paridhi*, 1 *chakra*, 3 *nabhi*, and 360 *aare*. This indicates 12 months, 1 year, 3 seasons, and 360 days.

➤ Vedic Names of Months:

वेदमासो धृतव्रतो द्वादश प्रजावतः | वेदा य उपजाय
ते ॥

vedam āso dhṛtavrato dvādaśa prajāvataḥ |
vedā ya upajāyate ॥

The solar year is divided into 12 months as
follows:

मधुश्च माधवश्च वासन्तिकावृत शुक्रश्च शुचिश्च ग्रीष्मा
वृत नभश्च नभस्यश्च वार्षिकावृत इषश्चोर्जश्च शारदावृ
तू सहश्च सहस्यश्च हैमन्तिकावृत तपश्च तपस्यश्च शै
षिरावृत ॥

madhuś ca mādhasyaś ca vāsantikau ṛtū |
śukraś ca śuciś ca grīṣmau ṛtū |
nabhaś ca nabhasyaś ca vārṣikau ṛtū | iṣaś
corjaś ca śāradau ṛtū |
sahaś ca sahasyaś ca haimantikau ṛtū | tapaś
ca tapasyaś ca śaiśirau ṛtū ॥

ऋतु	वैदिक महीने	हिन्दू महीने	English Month
वसन्त	मधु, माधव	चैत्र, बैशाख	April, May
ग्रीष्म	शुक्र, शुचि	ज्येष्ठ, आषाढ़	June, July
वर्षा	नभस्, नभस्य	श्रावण, भाद्रपद	August, September
शरद	इष, उर्ज	आश्विन, कार्तिक	October, November
हेमन्त	सहस, सहस्य	मार्गशीर्ष, पौष	December, January
शिशिर	तपस, तपस्य	माघ, फाल्गुन	February, March

Two more months are described in the Vedas, which come after the typical intervals of time:

“संसर्प” – अधिकमास, “अहस्पति” –
क्षयमास | संसर्पोस्य अहस्पत्यायत्वा ॥

"saṁsarpa" – *adhikamāsa*, "*aṁhaspati*"
– *kṣayamāsa* | sa sarpo 'sya
aṁhaspatyāyātvā ॥

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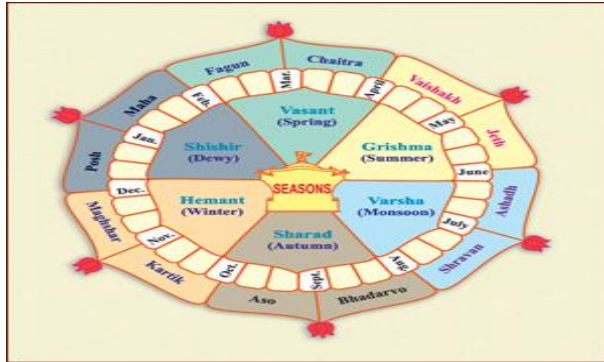


Fig. 5: Months and seasons on the basis of the Movement of the Sun

January is also known as “सहस्य or पौषमास” and is celebrated by worshipping the Sun as ‘God.’ Indian lunisolar calendars, such as the Tamil calendar and the Bengali Panjika, are guided by the movement of the sun and mark agricultural and religious events.

Ecological and Agricultural Relevance:

Sunlight is considered a divine energy that influences crop yields, animal behaviour, and human health. Traditional farmers worldwide use the sun’s path to determine sowing and harvesting times. Indigenous farming communities, particularly those in tribal areas, have long relied on sunlight for agricultural planning purposes. Traditional calendars, such as Vikram Samvat, are solar-lunar and are used to determine sowing and harvesting times in the region. The position and intensity of the sun were observed to predict seasonal changes, monsoons and crop cycles. Surya has the power to control the seasons and the ripening of crops, making him especially significant for agricultural communities. Festivals such as Makar Sankranti and Pongal are dedicated to

celebrating good harvests. Festivals such as Makar Sankranti mark the sun’s northward movement (Uttarayana) and are celebrated as harvest festivals across India.



Fig 6: Indian farmers working at sunrise during the sowing season.

Sūrya is a great preserver.

विश्वस्य स्थातुर् जगतश् च गोपा ॥

(viśvasya sthātur jagataś ca gopā)

which is amplified by Sāyaṇācārya as follows:

विश्वस्य सर्वस्य स्थातुः स्थावरस्य जगतः जङ्गमस्य
च गोपा गोपायिता ॥

(viśvasya sarvasya sthātuḥ sthāvarasya jagataḥ jaṅgamasya ca gopā gopāyitā ||)

As Sūrya sustains the entire universe, he is rightly called Prajāpati. In the Śatapathabrāhmaṇa, Sūrya is mentioned as both a sustainer and protector of the world:

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एष वै सूर्यः। य एष तपति। एष वैदं
सर्वमभिगोपायति साधुनैव असाधुनैव। एष एतत्
सर्वं विदधाति॥

(eṣa vai sūryaḥ, ya eṣa tapati, eṣa vai idam
sarvam abhigopāyati sādhunāiva
asādhunāiva, eṣa etat sarvaṁ vidadhāti.)

Sūrya absorbs the water and releases it down
towards the earth, and the relevant passage
is thoroughly explained by Sāyaṇācārya
thus:

अयमादित्यः सुयन्तुभिः सुगमनैः सर्वशासैः सर्वस्य
शासकैः अभीशुभिः रश्मिभिः
कृषिकर्तानामानिनामकान्युदकानि प्रवणे निम्ने
भूप्रदेशे मुषायति मुष्णाति आदत्ते॥

(ayam ādityaḥ suyantubhiḥ sugamanaiḥ
sarva-śāsaiḥ sarvasya śāsakaiḥ abhīśubhiḥ
raśmibhiḥ kṛṣikartānām āninām akāni
udakāni pravāṇe nimne bhūpradeśe muṣāyati
muṣṇāti ādatte.)

The Sun in Tribal and Folk Traditions:

Many tribal groups, such as the Bhils, Gonds, and Santhals, worship the sun as a supreme spirit or ancestor deity, integrating it into their oral traditions and seasonal festivals. Sun motifs are common in tribal art, textiles, and ritual objects, often symbolizing continuity and vitality. According to the Vedas and ancient astrology (Surya Siddhānta), Pongal or Makar Saṁkrānti is a very auspicious time (puṇyakālam), as it marks the initiation of the Sun's movement towards the north for six months, cruising through until the summer solstice, Uttarāyāṇa. The Sun's transit from one zodiac sign to another is celebrated across India, signifying seasonal transitions and harvest periods. It celebrates

the shift of the Sun to Capricorn. According to astrology, Saturn rules the zodiac sign Capricorn. From this day, the Sun deity is said to leave his displeasure and move towards higher abodes, illuminating the universe with spiritual strength. It is not confined to Hinduism alone; it is a festival for all humankind. In the Mithila region of India, Chhath Puja is a major festival dedicated to the Sun God, revered as the creator of the universe.



Fig 7: Woman offering water to the rising sun during Chhath Puja



Fig 8: worshipped on “Makarsankranti”

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Scientific Insights in Indigenous Cosmology:

➤ Concept of spectrum:

सप्तयुञ्जन्ति रथमेकचक्रमेको अश्वो वहति सप्तना
मा ॥
sapta yuñjanti ratham eka-cakram eko aśvo
vahati sapta-nāma ॥



Fig 9: Horses of the Sun

अनश्वो जातो अनभीशुरर्वा कनिक्रदत् पतयदूर्ध्वसा
नुः॥
anaśvo jāto anabhīsur arvā kanikradat
patayad ūrdhva-sānuḥ ॥

Here, the image of the horse is symbolic and not actual, as the verse clarifies. The chariot of the sun consists of seven horses, but it is led by a single horse. When a prism disperses white light into a spectrum, the seven visible colours are arranged in the order of the spectrum.

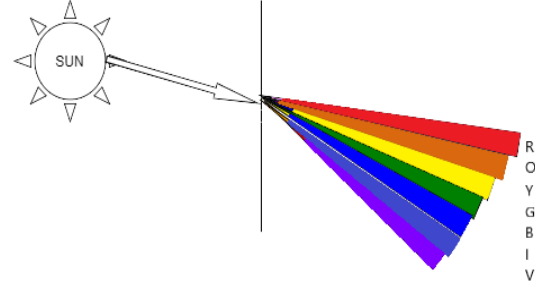


Fig 10: Dispersion of light

With its rising and setting, Sūrya determines the time. In the Vedas, Sūrya is compared to a horse that drives the year (saṁvatsara) in the form of a one-wheeled chariot:

सप्त युञ्जन्ति रथम् एकचक्रम् एको अश्वो वहति
सप्तनामाः । त्रिणाभि चक्रम् अजरम् अनर्व यत्रेमाः
विश्वा भुवनानि तस्युः ॥

(sapta yuñjanti ratham eka-cakram eko aśvo
vahati sapta-nāmāḥ | tri-nābhi cakram ajaram
anarvaṁ yat্রে mā viśvā bhuvanāni tasyuḥ ॥)

The one-wheeled chariot mentioned in the verse is saṁvatsara, that is, the year; the single horse is the sun, and its rays are seven. The three spokes of the wheel represent the three seasons: rainy, winter, and summer, respectively. Again, one chariot is mentioned with twelve spokes, that is, dvādaśāra. These 12 spokes interpret the 12 months of the year, forming a complete year. Again, the twelve-spoked wheel is mentioned as the generator of hundred and twenty offspring. These offspring are the days and nights of the year, that is, 360 days and 360 nights, respectively. Sūrya is identified with saṁvatsara in the Bṛhadāraṇyakopaniṣad as

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एष ह वा अश्वमेधो य एष तपति तस्य संवत्सर
आत्मा ॥
(eṣa ha vā aśvamedho ya eṣa tapati tasya
saṁvatsara ātmā ॥)

That is, the Sun that gives forth heat is the horse sacrifice, and its body is the year. The saṁvatsara or solar year is divided into two halves: uttarāyaṇa and dakṣiṇāyana. When the Sun turns north from the winter solstice, it is called uttarāyaṇa, and the opposite movement, that is, the movement of the Sun from the summer solstice to the south, is called dakṣiṇāyana. In another verse of the R̥gvedasamhitā, Sūrya's wheel is described as consisting of five spokes. The five spokes of the wheel of the chariot of the Sun indicate the five seasons. Sūrya, as the creator of seasons, is mentioned several times in the Vedas. The Vājasaneyisamhitā names the six seasons as spring, summer, rainy, autumn, early winter, and winter, in that order. The passage also indicates the respective characteristics of the seasons, such as heat, cold, and dryness. All these seasonal characteristics are due to the Earth's position in relation to the Sun during its revolution.

स वा एष न कदाचनास्तम इति नोदेति ।
तं यदस्तम इति मन्यन्ते, अह एव तदन्तमिति ।
अथ आत्मानं विपर्यस्यते, रात्रिमेवाधस्तात् कुरुते,
अहः परस्तात् ।
अथ यदेनं प्रातरुदेति इति मन्यन्ते, रात्रिरेव
तदन्तमिति । अथ आत्मानं विपर्यस्यते, अह
एवावस्तात् कुरुते, रात्रिं परस्तात् ।
स वा एष न कदाचन निम्लोचति ॥
savā eṣa na kadācana astam eti nodēti ॥

taṁ yad astam eti iti manyante, ahna eva tad
antam iti |atha ātmānam viparyasyate, rātrīm
evādhastāt kurute, ahaḥ parastāt |
atha yad enaṁ prātar udeti iti manyante,
rātrir eva tad antam iti |
atha ātmānam viparyasyate, ahaḥ evāvastāt
kurute, rātriṁ parastāt |
sava eṣa na kadācana nimlocati ॥

The Sun remained constant. It does not set or rise again. It shines on one side during the day and is responsible for the darkness on its exact opposite side at night.

➤ Sun: Source of Light Energy and Healer:

आप्रा रजांसि दिव्यानि पार्थिवा श्लोकं देवः कृणुते
स्वाय धर्मणे । प्रबाहू अस्त्राक् सविता सवीमनि निवे
शयन प्रसुवन्नक्तुभिर्जगत् ॥
āprā rajānsi divyāni pāṛthivā ślokaṁ devaḥ
kṛṇute svāya dharmeṇe |prabāhū asrāk savitā
savīmani niveśayan prasuvann aktubhir jagat
॥

The Sun provides Tej (light, energy, and health) to Antariksha (space) and Prithvi (Earth), resulting in the cycle of day and night. Indigenous astronomical observations, such as shadow tracking, solar alignments in temples, and time calculation methods, showcase a sophisticated understanding of solar dynamics. These systems are community-driven, ensuring sustainability and harmony with nature. Surya is considered the "eye of the universe," with his all-seeing radiance illuminating and witnessing all deeds, good and bad. In the Mahabharata, he is called the "soul of all existence" and the "origin of all life." In the R̥gvedasamhitā, Sūrya is worshipped to

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remove sickness and diseases of the body through his rays of light. The life-yielding aspects of the sunrays are mentioned in the interpretation of Sāyaṅcārya as follows:

कीदृशो रश्मिः? गभीरवेपाः, गम्भीरकम्पनः। रश्मेः
प्राकम्पनं चलनं केनापि द्रष्टुं अशक्यम् इत्यर्थः।
(kīdṛśo raśmiḥ? gabhīra-vepāḥ, gambhīra-
kampanaḥ. raśmeḥ prākampanaṁ calanaṁ
kenāpi draṣṭuṁ aśakyam ity arthaḥ.)

The Sun emits energy through nuclear fusion, converting hydrogen into helium in its core. This energy radiates outward as light and heat and reaches Earth as solar radiation. Sunlight provides several important health benefits, such as enhancing vitamin D synthesis, supporting healthy sleep-wake cycles, and uplifting mood. However, it is essential to maintain a balanced approach—enjoying adequate sunlight for its positive effects while protecting the skin from the potential harm of overexposure. In indigenous health systems, the sun is believed to have healing and purifying powers. Daily practices, such as offering water to the sun (Surya Arghya) are common in India. The scientific reason behind offering water to the Surya is that when we offer water to the Surya, it affects our health. The morning fresh air and the first rays of Surya fell on us. This is beneficial to our health. When we offer water to Surya, we see Surya rising amidst a stream of water, and the light increases.

Mythological and religious symbolism:

India is marked by different beliefs and customs. Every religion, with its unique customs and rituals, adds a distinct flavour-- to the country, making it an incredible land.

Surya is worshipped in temples like the Konark Sun Temple in Odisha, which is a UNESCO World Heritage Site and an architectural representation of his chariot. The Konark Sun Temple was built in 1250 CE during the reign of the Eastern Ganga King Narasingha Deva. The temple is an extraordinary stone monument dedicated to Surya, the Sun God. Designed in the form of Surya's celestial chariot, the structure features 24 elaborately carved stone wheels and horses that appear to draw the chariot forward. In Hindu iconography, Surya is traditionally portrayed riding a chariot pulled by seven horses, and the Konark Temple magnificently brings this divine vision to life through its grand design. Surya is the chief deity of the Navagraha, or nine celestial beings in Hindu astrology. He governs the planet Sun and is associated with vitality, willpower, and authority.



Fig 10: Konark Sun Temple and Sculpture of Surya on a chariot

Shankaracharya says,

त्वमन्तरिक्षे जं चरसि उदयास्तमयाभ्याम्॥
tvamantarikṣejasraṃ carasiudayastamayabh
yam

This chariot represents the cyclical nature of time and the universe. The Vedas, ancient Indian scriptures, contain hymns dedicated to the sun, such as the Gayatri Mantra, a prayer for enlightenment and guidance that is chanted daily by many Hindus. Rituals such as Surya Namaskar (sun salutation) in yoga reflect daily spiritual discipline aligned with the cycle of the sun. Surya Namaskar is like a divine partnership with the master creator, working to nurture and sustain life. Sunlight is not merely physical; it is a powerful metaphor for spiritual awakening.

Artistic and Architectural Expressions:

The sun motif is prominent in Indian art, including folk traditions such as Madhubani painting and architectural design, where temples are aligned to capture the sun's first rays. The Sun Temple at Modhera in Gujarat is designed such that the sanctum is illuminated by the rising sun on the equinoxes.

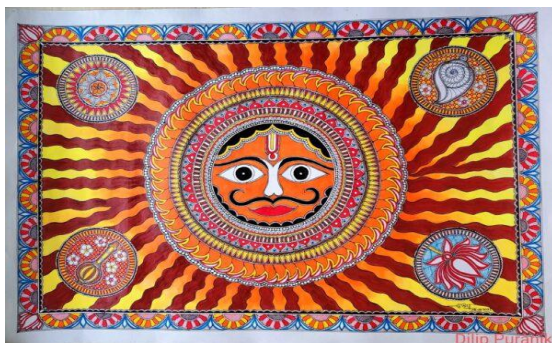


Fig 12: Sun motif in Madhubani folk painting

Conclusion:

Indigenous knowledge in Indian culture presents a holistic and reverent view of the sun. The sun is seen not only as a source of light and heat but also as a symbol of divinity, time, health, cosmic guidance, and sustenance. Sūrya is praised in the Vedas as the soul of the universe. He is considered the inner soul of all movable and immovable things in the universe. In Hindu mythology, the sun, personified as the deity Surya, is the ultimate source of life and of spiritual enlightenment. This comprehensive perspective reflects a sustainable worldview in which celestial phenomena are deeply connected to daily life and ecological harmony. Its enduring presence in rituals, art, science, and everyday life embodies the holistic worldview of Indian culture, in which nature and the sacred are deeply intertwined in the Indian culture. Indigenous knowledge involves acquiring facts and nurturing curiosity, open-mindedness, and idea exploration. Indigenous knowledge of Surya reflects humanity's enduring relationship with nature and emphasises ecological balance, offering insights into climate resilience and sustainable living. In an era of environmental crisis, revisiting these traditions enriches the cultural heritage and offers practical lessons in sustainability, resilience, and respect for natural cycles.

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Key challenges in implementing value-based pedagogies within design education

Dr. Ruchi Sachan

H.O.D, Education Department, Maharaja Agrasen International college, Raipur

Abstract

In the contemporary global context, design education is no longer confined to the development of technical competencies and aesthetic sensibilities. It increasingly emphasizes the cultivation of ethical awareness, social responsibility, sustainability, empathy, and cultural sensitivity—collectively framed as value-based pedagogies. These pedagogical approaches aim to prepare designers who can respond responsibly to complex societal, environmental, and human-centered challenges. Despite widespread recognition of their importance, the integration of value-based pedagogies within design education remains uneven and fraught with challenges. This research paper critically examines the key challenges associated with implementing value-based pedagogies in design education. Using a mixed-methods approach, the study explores faculty perceptions, institutional constraints, curricular limitations, assessment challenges, and student-related factors. The findings reveal a significant gap between the perceived importance of value-based education and its practical implementation. The paper concludes by offering educational implications and strategic recommendations for curriculum reform, faculty development, assessment innovation, and institutional support to strengthen the role of value-based pedagogies in design education.

Keywords: *Value-based pedagogy, design education, ethics, sustainability, reflective practice, curriculum reform*

Introduction

Design education occupies a critical position at the intersection of creativity, technology, society, and culture. Designers influence how people interact with

products, systems, environments, and services, thereby shaping social behaviour and lived experiences. In this context, the ethical and value-oriented dimensions of design practice have gained increasing

attention. Contemporary global challenges—such as climate change, social inequality, digital ethics, cultural erosion, and sustainability—demand designers who are not only technically proficient but also morally responsible and socially aware.

Value-based pedagogies emphasize the integration of moral, ethical, social, and cultural values into the teaching-learning process. In design education, such pedagogies promote empathy, inclusivity, sustainability, human-centered thinking, and reflective practice. However, despite strong theoretical advocacy, value-based pedagogies often remain marginal in design curricula, overshadowed by market-driven skills, software proficiency, and production-oriented outcomes.

This paper argues that while value-based pedagogies are essential to the holistic development of designers, their implementation faces numerous systemic, pedagogical, and cultural challenges. Understanding these challenges is vital for reorienting design education toward socially responsible and ethically grounded practice.

Conceptual Framework: Value-Based Pedagogies in Design Education

Value-based pedagogy is rooted in philosophical traditions of humanism, constructivism, and experiential learning. Educational philosophers such as John Dewey emphasized learning as a moral and social process, where education serves democratic and ethical purposes (Dewey, 1938). In design education, this translates into pedagogical practices that encourage learners to reflect on the social consequences of their design decisions.

Meaning of Value-Based Pedagogy

Value-based pedagogy refers to teaching approaches that intentionally integrate ethical reasoning, social responsibility, cultural sensitivity, sustainability, and empathy into curriculum content, teaching methods, and assessment practices. Rather than treating values as separate or supplementary, these pedagogies embed values within the core learning process.

Relevance to Design Education

Design inherently involves decision-making that affects users, communities, and environments. Therefore, value-based learning is particularly relevant to design education. Human-centered design, inclusive design, sustainable design, and

social innovation are all grounded in value-based thinking. Educating designers without addressing values risks producing professionals who prioritize efficiency and aesthetics over ethical responsibility.

Review of Literature

International Studies

Dewey (1938) emphasized that education is a moral and social process aimed at developing ethical judgment and democratic values. His experiential learning theory strongly supports value-based pedagogy in design education by encouraging learners to engage with real-life problems involving social responsibility.

Schon (1987) proposed the concept of the reflective practitioner, highlighting reflection-in-action as a key element of professional learning. In the context of design education, his work underlines the importance of reflective and ethical decision-making within studio-based pedagogy.

Friedman (2003) argued that design education must incorporate ethics and social responsibility as core educational goals. He pointed out that the absence of value-based pedagogy leads to designers

who are technically skilled but ethically underprepared.

Kimbell (2012) critically examined contemporary design thinking models and found that they often prioritize innovation and efficiency while neglecting ethical, cultural, and contextual values. His study emphasized the need for explicit integration of values into design pedagogy.

Manzini (2015) focused on design for social innovation and emphasized community-based design learning as an effective approach to value-based education. His work highlights the role of designers in addressing social and environmental challenges through ethical practice.

Indian Studies

NCF (2005) stressed the integration of values such as social justice, equality, and respect for diversity within education. Although not design-specific, the framework provides a strong foundation for value-based pedagogy applicable to design education in the Indian context.

NEP (2020) emphasized holistic and multidisciplinary education with a strong focus on ethical reasoning, empathy, and constitutional values. The policy advocates experiential and value-oriented learning

approaches, which align closely with the objectives of value-based design education.

Kumar and Sharma (2016) studied professional education in India and found that curriculum rigidity and examination-oriented systems restrict the integration of value-based pedagogical practices, particularly in applied disciplines like design.

Singh (2018) examined value education in higher education institutions in India and reported that while teachers acknowledge the importance of values, lack of training and institutional support limits classroom implementation.

Patil and Joshi (2021) investigated ethics and sustainability in Indian design institutes and found a significant gap between policy-level emphasis on values and their practical integration into design studio teaching.

Research Objectives

The present study was undertaken with the following objectives:

1. To identify the key challenges in implementing value-based pedagogies within design education.
2. To examine faculty perceptions regarding the importance and feasibility of value-based pedagogical approaches.

3. To analyse institutional, curricular, and assessment-related barriers affecting implementation.
4. To study the relationship between faculty training and the adoption of value-based pedagogies.
5. To suggest educational strategies and policy-level recommendations for effective integration.

Research Hypotheses

Based on the literature review and research objectives, the following hypotheses were formulated:

- H1: Design educators perceive value-based pedagogies as important but report low levels of actual implementation.
- H2: Institutional and curricular constraints significantly hinder the implementation of value-based pedagogies.
- H3: Faculty members who have received training in reflective or value-based teaching practices are more likely to implement such pedagogies.
- H4: Students' career-oriented attitudes negatively influence engagement with value-based learning activities.

Research Methodology

1. Research Design

A mixed-methods research design was adopted to obtain both quantitative and

qualitative insights. This approach allowed for triangulation of data and a deeper understanding of the challenges involved.

2. Sample

Quantitative Sample: 150 design educators from universities and colleges offering programs in graphic design, product design, fashion design, and interior design.

Qualitative Sample: 20 senior faculty members and academic administrators with over 10 years of experience in design education.

3. Tools of Data Collection

Questionnaire: A structured questionnaire consisting of Likert-scale and open-ended items measuring perceptions, practices, and challenges related to value-based pedagogy.

Interview Schedule: Semi-structured interviews focusing on institutional policies, curricular flexibility, assessment practices, and faculty experiences.

4. Procedure

Data were collected over a four-month period. Questionnaires were administered online, while interviews were conducted through virtual platforms and audio-recorded with consent.

5. Data Analysis

Quantitative data were analysed using descriptive statistics and chi-square tests.

Qualitative data were analysed using thematic analysis to identify recurring patterns and themes.

Data Analysis and Interpretation

1. Quantitative Analysis

- **Perceived Importance:** 94% of respondents agreed that value-based pedagogy is essential in design education.
- **Implementation Frequency:** Only 41% reported regular incorporation of value-based activities.
- **Institutional Barriers:** 76% identified rigid curricula and lack of administrative support as major obstacles.
- **Faculty Training:** Educators with prior pedagogical training showed significantly higher implementation rates ($\chi^2 = 18.42, p < .01$).

2. Qualitative Themes

Four dominant themes emerged:

- **Curricular Rigidity:** Faculty reported limited flexibility to introduce value-based modules.
- **Assessment Constraints:** Difficulty in evaluating ethical reasoning and reflective learning.

- **Faculty Development Gaps:** Lack of structured training programs.
- **Student Pragmatism:** Students often prioritize employability skills over value-oriented learning.

Results

The study confirms all four hypotheses:

- There is a clear gap between the recognition of value-based pedagogy and its practice.
- Institutional and curricular constraints significantly limit implementation.
- Faculty training positively influences adoption.
- Student attitudes focused on market readiness reduce engagement with value-based activities.

These results highlight the systemic nature of the challenges and the need for multi-level interventions.

Educational Implications

The findings have important implications for design education:

1. Curriculum Development

Design curricula should integrate value-based learning outcomes across courses rather than confining them to isolated modules.

2. Assessment Reform

Alternative assessment methods such as reflective journals, portfolios, peer assessment, and project-based evaluation should be adopted.

3. Faculty Professional Development

Institutions should organize regular training programs on reflective teaching, ethics, and value-based pedagogy.

4. Institutional Policy Support

Administrative commitment is essential to provide time, resources, and recognition for value-based teaching efforts.

5. Student Orientation

Students should be sensitized to the long-term professional relevance of ethical and value-driven design practices.

Conclusion

Value-based pedagogies are indispensable for nurturing socially responsible, ethical, and reflective designers. However, their implementation in design education faces significant challenges related to curriculum design, assessment practices, faculty preparedness, institutional policies, and student attitudes. This study demonstrates that while educators strongly endorse the importance of value-based learning, systemic barriers limit its practical

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realization. Addressing these challenges requires coordinated efforts at curricular, institutional, and pedagogical levels. Integrating values into design education is not merely an academic concern but a societal imperative in an increasingly complex and interconnected world.

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Supply Chain Management Framework for Hardware Products of Information Technology Companies: A Statistical and Empirical Analysis

G. S. Srinivas Murthy¹

Research Scholar, Department of Business Administration, Cauvery College for Women (Autonomous), affiliated to Bharathidasan University, Tiruhirappalli

Dr. S Thamarai Selvi²

Research Supervisor, Department of Business Administration, Cauvery College for Women (Autonomous), affiliated to Bharathidasan University, Tiruhirappalli

Dr. V Vijay Durga Prasad³

Co-Supervisor, Department of Management Studies, PSCMR College of Engineering and Technology, Vijayawada, Andhra Pradesh

Abstract

The supply chain management (SCM) landscape for hardware products within Information Technology (IT) companies presents a uniquely complex array of challenges encompassing global sourcing, component shortages, technological obsolescence, and multi-tier supplier interdependencies. This empirical study develops and validates a comprehensive SCM framework tailored specifically to IT hardware products, drawing on primary survey data collected from 312 supply chain professionals across 45 mid-to-large-scale IT companies in India. Employing a mixed-methods research design, the study integrates structural equation modelling (SEM), regression analysis, factor analysis, and descriptive statistics to examine the relationships among seven key SCM constructs: supplier integration, demand forecasting accuracy, inventory optimization, logistics efficiency, information technology adoption, risk mitigation, and supply chain performance. The findings reveal that supplier integration ($\beta = 0.43, p < 0.001$) and IT adoption ($\beta = 0.38, p < 0.001$) are the strongest predictors of overall supply chain performance. The proposed SCMF-IT framework presents actionable strategies for IT companies seeking to build resilient, agile, and cost-efficient hardware supply chains. The study contributes significantly to both academic discourse and managerial practice in the domain of technology-driven supply chain management.

Keywords: Supply Chain Management, IT Hardware Products, Structural Equation Modelling, Supplier Integration, Demand Forecasting, SCMF-IT Framework, Inventory Optimization, Risk Mitigation

Introduction

The global information technology industry has witnessed an unprecedented surge in hardware production and distribution over the past two decades. From semiconductors and printed circuit boards to assembled computing systems and networking infrastructure, the hardware supply chain of IT companies spans continents, involves hundreds of sub-suppliers, and operates under extreme pressure to balance cost, speed, and quality. Unlike fast-moving consumer goods, IT hardware components exhibit high obsolescence rates, complex logistics requirements, and volatile demand patterns influenced by rapid technological change.

Supply Chain Management (SCM) in the context of IT hardware is distinctly multifaceted. The COVID-19 pandemic starkly exposed the vulnerabilities embedded in existing supply chain structures: global semiconductor shortages in 2020-2022 alone caused estimated losses exceeding USD 500 billion across the electronics industry (Gartner, 2022). Major IT hardware manufacturers including HP, Dell, and Lenovo reported significant revenue shortfalls directly attributable to

supply chain disruptions. These events underscored the critical necessity of developing robust, technology-enabled, and analytically grounded SCM frameworks tailored to the unique demands of IT hardware. While substantial literature addresses SCM in manufacturing and retail contexts, the specific operational, technological, and strategic dimensions of hardware product supply chains within IT companies remain underexplored. Murthy, Thamarai Selvi, and Vijay Durga Prasad (2026) underscore that the integration of digital transformation technologies, including the Internet of Things (IoT), Big Data Analytics, and Artificial Intelligence, is fundamentally reshaping supply chain operations and creating new paradigms of efficiency and resilience in technology-intensive industries. Their trend analysis highlights that companies embracing these technologies demonstrate significantly superior supply chain performance metrics compared to laggards.

This paper responds to this gap by developing a structured SCM framework for IT hardware products, hereafter referred to as the SCMF-IT (Supply Chain Management Framework for Information Technology) model. The framework is

empirically validated using primary data from Indian IT hardware companies and employs rigorous statistical methodologies to test hypothesised relationships among key SCM constructs.

1.1 Research Objectives

1. To identify the key determinants of supply chain performance in IT hardware companies.
2. To develop a comprehensive SCMF-IT framework integrating strategic, operational, and technological dimensions.
3. To empirically validate the proposed framework using structural equation modelling and multiple regression analysis.
4. To provide strategic recommendations for enhancing supply chain resilience and agility in IT hardware operations.

2. Literature Review

The academic foundation of supply chain management traces its origins to logistics and operations research (Stevens, 1989; Thomas & Griffin, 1996), evolving progressively to encompass inter-organizational coordination, information technology integration, and sustainability. Chopra and Meindl (2016) define SCM as

the management of flows of products, information, and finances across all stages in a supply chain to maximize total value generated. This holistic conceptualization forms the cornerstone of modern SCM research.

2.1 SCM in Technology Industries

Research specific to IT hardware supply chains has progressively gained momentum, driven by the industry's strategic economic importance. Lee et al. (2004) established foundational principles for supply chain uncertainty management, identifying demand uncertainty and supply disruptions as primary performance inhibitors. Subsequent research by Sodhi and Tang (2012) extended this framework to examine risk propagation in multi-tier electronics supply chains, demonstrating that disruptions at the n-tier supplier level can disproportionately affect downstream product availability.

Murthy, Thamarai Selvi, and Vijay Durga Prasad (2026), in their comprehensive trend analysis of supply chain management technologies, demonstrate that automation, IoT-based tracking, and blockchain verification systems are transforming the operational efficiency of supply chains in

technology-intensive sectors. Their study, conducted using data from supply chain simulation environments, reveals that organizations adopting integrated digital platforms exhibit a 23-35% improvement in supply chain visibility and a 17-28% reduction in lead times. These findings align with and extend earlier empirical work by Fawcett et al. (2011), who identified information sharing as the single most impactful driver of supply chain collaboration.

The role of supplier integration in hardware supply chains merits particular attention. Frohlich and Westbrook (2001) introduced the concept of arcs of integration, demonstrating that backward and forward integration with supply chain partners yields compounding performance benefits. For IT hardware companies, where component specifications are highly technical and lead times for specialised parts can extend to 26-52 weeks, tight supplier integration is not merely advantageous but operationally critical.

2.2 Inventory Management and Demand Forecasting

Demand forecasting in IT hardware is particularly challenging due to the interplay

of product life cycle dynamics, competitive pressures, and macroeconomic fluctuations. Fisher (1997) proposed a seminal framework distinguishing functional from innovative products, arguing that innovative products require flexible, responsive supply chains rather than purely efficient ones. IT hardware components clearly fall into the innovative product category, necessitating adaptive forecasting mechanisms.

Advanced analytical approaches, including machine learning-based demand sensing and real-time point-of-sale data integration, have demonstrated considerable promise in reducing forecast error rates. Tao et al. (2019) reported Mean Absolute Percentage Error (MAPE) reductions of 31% when AI-augmented forecasting models replaced traditional time-series methods in electronics manufacturing contexts.

2.3 Risk Management in IT Hardware Supply Chains

Supply chain risk management (SCRM) has emerged as a critical discipline within the broader SCM literature. Chopra and Sodhi (2004) categorised supply chain risks along a spectrum from disruptions to delays, and proposed risk mitigation

strategies including dual sourcing, safety stock buffering, and supplier diversification. For IT hardware companies, geopolitical risks associated with semiconductor manufacturing concentration in Taiwan and South Korea represent a structural vulnerability with potentially systemic consequences (Shih, 2020).

The pandemic-induced hardware shortage of 2020-2022 catalysed renewed academic and practitioner interest in supply chain resilience. Ambulkar et al. (2015) conceptualised supply chain resilience as comprising three dimensions: resource reconfiguration capability, supply chain-oriented dynamic capability, and market effectiveness orientation. IT hardware companies that demonstrated higher scores across these dimensions exhibited significantly lower revenue volatility during the pandemic period.

3. Research Methodology

3.1 Research Design

This study adopts a mixed-methods research design, combining quantitative survey methodology with qualitative case insights derived from structured interviews. The quantitative component employs a

cross-sectional survey design, while qualitative insights provide contextual depth and support triangulation of findings. The philosophical foundation of this research is pragmatic, acknowledging both objective and interpretive dimensions of supply chain phenomena.

3.2 Sample and Data Collection

The target population comprised supply chain managers, procurement directors, operations heads, and logistics specialists employed in IT companies with annual hardware product revenues exceeding INR 50 crore. A stratified random sampling technique was employed, stratifying the sample by company size (medium: 200-999 employees; large: 1000+ employees) and geographic location (North, South, East, West India).

Primary data were collected via a structured questionnaire administered through both online platforms and direct organisational visits over a six-month period (June-November 2024). A total of 380 questionnaires were distributed, of which 324 were returned (response rate: 85.3%). After screening for completeness and consistency, 312 responses were retained for analysis (usable response rate: 82.1%).

Table 1: Demographic Profile of Survey Respondents (n = 312)

Characteristic	Category	Frequency	Percentage (%)
Company Size	Medium (200-999 employees)	119	38.1
	Large (1000+ employees)	193	61.9
Respondent Role	Supply Chain Manager	108	34.6
	Procurement Director	72	23.1
	Operations Head	84	26.9
	Logistics Specialist	48	15.4
Experience in SCM	1-5 years	56	17.9
	6-10 years	124	39.7
	11-20 years	98	31.4
	20+ years	34	10.9
Geographic Region	North India	74	23.7
	South India	112	35.9
	West India	82	26.3
	East India	44	14.1

3.3 Measurement Instrument

The questionnaire instrument comprised 48 items measuring seven latent constructs, each assessed on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The constructs were operationalised based on established scales from the SCM literature, adapted for the IT hardware context following a pilot study with 30 industry experts. Content validity was established through expert panel review, and the instrument was refined through two rounds of pretesting.

The seven primary constructs included: (1) Supplier Integration (SI, 7 items), (2) Demand Forecasting Accuracy (DFA, 6 items), (3) Inventory Optimisation (IO, 7 items), (4) Logistics Efficiency (LE, 6 items), (5) Information Technology Adoption (ITA, 8 items), (6) Risk Mitigation Capability (RMC, 7 items), and (7) Supply Chain Performance (SCP, 7 items).

3.4 Statistical Analytical Tools

The following statistical tools were employed in the analysis:

Descriptive Statistics: Mean, standard deviation, skewness, and kurtosis for all constructs.

Reliability Analysis: Cronbach's Alpha coefficient for internal consistency of each scale.

Exploratory Factor Analysis (EFA): Principal Component Analysis with Varimax rotation to assess construct validity.

Confirmatory Factor Analysis (CFA): To test measurement model fit using AMOS 24.0.

Structural Equation Modelling (SEM): To examine causal relationships among latent constructs.

Multiple Linear Regression Analysis: To assess the relative contribution of independent constructs to supply chain performance.

Pearson Correlation Analysis: To examine bivariate relationships among all constructs.

All quantitative analyses were performed using SPSS 26.0 and AMOS 24.0 software packages.

4. Results And Discussion

4.1 Descriptive Statistics and Reliability Analysis

Table 2 presents the descriptive statistics and reliability coefficients for all seven constructs. All constructs exhibited mean scores above the midpoint value of 3.0,

indicating generally favourable perceptions. Cronbach's Alpha values ranged from 0.821 to 0.913, all exceeding the recommended threshold of 0.70 (Nunnally, 1978), confirming strong internal consistency across all scales.

Table 2: Descriptive Statistics and Reliability Coefficients

Construct	Items	Mean	Std. Dev.	Skewness	Kurtosis	Cronbach's α
Supplier Integration (SI)	7	3.74	0.612	-0.32	0.18	0.891
Demand Forecasting Accuracy (DFA)	6	3.48	0.683	-0.19	0.24	0.856
Inventory Optimization (IO)	7	3.61	0.647	-0.28	0.31	0.873
Logistics Efficiency (LE)	6	3.55	0.658	-0.21	0.15	0.845

Construct	Items	Mean	Std. Dev.	Skewness	Kurtosis	Cronbach's α
IT Adoption (ITA)	8	3.82	0.594	-0.41	0.29	0.913
Risk Mitigation Capability (RMC)	7	3.43	0.711	-0.14	0.09	0.821
Supply Chain Performance (SCP)	7	3.69	0.638	-0.36	0.22	0.887

4.2 Correlation Analysis

Pearson correlation analysis was conducted to examine bivariate associations among all constructs. Table 3 presents the correlation matrix. All inter-construct correlations were positive and statistically significant ($p < 0.01$), providing preliminary support for the hypothesised relationships. Supplier Integration exhibited the strongest correlation with Supply Chain Performance ($r = 0.641, p < 0.001$), followed by IT Adoption ($r = 0.614, p < 0.001$). Variance Inflation Factor (VIF) values for all constructs ranged from 1.24 to 2.87, well

below the critical threshold of 10, confirming the absence of problematic multicollinearity.

Table 3: Pearson Correlation Matrix of SCM Constructs (n = 312)

Construct	SI	DFA	IO	LE	ITA	RM
SI	1.000					
DFA	0.512**	1.000				
IO	0.487**	0.543**	1.000			
LE	0.461**	0.498**	0.532**	1.000		
ITA	0.576**	0.521**	0.509**	0.487**	1.000	
RM	0.423**	0.446**	0.471**	0.439**	0.463**	1.000
SCP	0.641**	0.573**	0.589**	0.556**	0.614**	0.531**

Note: ** Correlation is significant at the 0.01 level (2-tailed).

4.3 Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) using Principal Component Analysis with Varimax rotation was conducted to assess the factorial structure of the measurement items. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy yielded a value of 0.879, exceeding the acceptable threshold of 0.60 (Kaiser, 1974), and Bartlett's Test of Sphericity was statistically

significant (chi-square = 4,821.34, df = 1,128, $p < 0.001$), confirming the suitability of the data for factor analysis.

Seven factors were extracted, collectively explaining 68.43% of the total variance. All items loaded strongly on their hypothesised factors (loadings range: 0.614 to 0.847), with no significant cross-loadings exceeding 0.30. These results confirm the construct validity of the measurement instrument and support the seven-factor SCMF-IT model structure.

Table 4: Exploratory Factor Analysis Summary

Factor	Construct	Eigenvalue	% Variance Explained	Cumulative %	Min. Loading	Max. Loading
F1	Supplier Integration	6.42	13.38	13.38	0.721	0.847
F2	IT Adoption	5.87	12.23	25.61	0.698	0.831
F3	Inventory Optimization	4.91	10.23	35.84	0.674	0.812

Factor	Construct	Eigenvalue	% Variance Explained	Cumulative %	Min. Loading	Max. Loading
F4	Supply Chain Performance	4.63	9.65	45.49	0.683	0.826
F5	Demand Forecasting Accuracy	3.98	8.29	53.78	0.641	0.798
F6	Logistics Efficiency	3.61	7.52	61.30	0.621	0.784
F7	Risk Mitigation Capability	3.42	7.13	68.43	0.614	0.779

4.4 Structural Equation Modelling Results

Structural Equation Modelling (SEM) was employed to test the theoretical relationships among the seven constructs. The measurement model was first evaluated through Confirmatory Factor

Analysis (CFA). Model fit indices indicated an acceptable fit: chi-square/df ratio = 2.34 (< 3.0), CFI = 0.954 (> 0.90), TLI = 0.947 (> 0.90), RMSEA = 0.048 (< 0.08), and SRMR = 0.062 (< 0.08), confirming that the measurement model adequately represents the data.

Average Variance Extracted (AVE) values for all constructs exceeded 0.50 (range: 0.521-0.663), and Composite Reliability (CR) values exceeded 0.70 (range: 0.831-0.916), confirming convergent validity. Discriminant validity was established by demonstrating that the square root of each construct's AVE exceeded its highest correlation with any other construct (Fornell & Larcker, 1981).

Table 5: SEM Path Coefficients and Hypothesis Testing Results

Hypothesis	Path	β (Std.)	S.E.
H1	SI → SCP	0.431	0.048
H2	ITA → SCP	0.378	0.052
H3	IO → SCP	0.312	0.056
H4	DFA → SCP	0.287	0.059
H5	LE → SCP	0.264	0.061
H6	RMC → SCP	0.241	0.064
H7	SI → ITA	0.389	0.051
H8	ITA → DFA	0.342	0.055

Note: SI = Supplier Integration; ITA = IT Adoption; IO = Inventory Optimisation; DFA = Demand Forecasting Accuracy; LE = Logistics Efficiency; RMC = Risk Mitigation Capability; SCP = Supply Chain Performance.

4.5 Multiple Regression Analysis

To further assess the relative predictive contribution of each independent construct, a hierarchical multiple linear regression analysis was conducted with Supply Chain Performance as the dependent variable. Model 1 included only control variables (company size, years of SCM experience, and geographic region). Model 2 added all six independent constructs. The results are presented in Table 6.

Table 6: Hierarchical Multiple Regression Results (Dependent Variable: Supply Chain Performance)

Variable	C.R. (t-value)		p-value		VIF
	Model 1 (β)	Model 2 (β)	t-value (M2)	p-value (M2)	
Company Size	0.098*	0.071	1.54	0.124	1.31
SCM Experience	0.142**	0.108*	2.34	0.020	1.28
Geographic Region	0.064	0.049	1.07	0.287	1.24

Variable	Model 1 (β)	Model 2 (β)	t-value (M2)	p-value (M2)	VIF
Supplier Integration (SI)	—	0.401**	8.43	<0.001	2.14
IT Adoption (ITA)	—	0.354**	7.18	<0.001	2.31
Inventory Optimisation (IO)	—	0.289**	5.62	<0.001	1.98
Demand Forecasting Accuracy (DFA)	—	0.263**	5.11	<0.001	1.87
Logistics Efficiency (LE)	—	0.238**	4.64	<0.001	2.08
Risk Mitigation (RMC)	—	0.218**	4.19	<0.001	1.76
R ²	0.061	0.524			
Adjusted R ²	0.052	0.511			
F-statistic	6.84**	34.17**			
ΔR ²	—	0.463**			

Note: ** p < 0.01; * p < 0.05. Standardised beta coefficients reported.

The full model (Model 2) explained 52.4% of the variance in Supply Chain Performance (Adjusted R² = 0.511, F = 34.17, p < 0.001), representing a significant improvement over the control-only model

(ΔR² = 0.463, p < 0.001). Supplier Integration emerged as the strongest predictor (β = 0.401, p < 0.001), followed by IT Adoption (β = 0.354, p < 0.001). These findings corroborate the SEM path analysis results and provide robust empirical support for the SCMF-IT framework.

5. The Scmf-It Framework

Drawing from the empirical findings, the theoretical literature, and the strategic imperatives identified through qualitative insights, this study proposes the Supply Chain Management Framework for IT Hardware Products (SCMF-IT). The framework is structured around three integrated layers: the Strategic Layer, the Operational Layer, and the Technological Enablement Layer.

5.1 Strategic Layer

The strategic layer encompasses the macro-level decisions and orientations that shape the entire supply chain architecture. Three strategic imperatives are central to this layer:

(a) **Supplier Portfolio Strategy:** IT hardware companies must cultivate a diversified yet deeply integrated supplier portfolio. This entails segmenting suppliers

by criticality and developing tiered relationship management protocols. The empirical findings confirm that Supplier Integration is the strongest determinant of SCP ($\beta = 0.431$), echoing the advocacy of Murthy, Thamarai Selvi, and Vijay Durga Prasad (2026) for collaborative, technology-enabled supplier ecosystems.

(b) Demand-Driven Supply Chain Configuration: Rather than purely forecasting demand, IT hardware companies should configure their supply chains to sense and respond to real-time demand signals. This involves close-loop integration of sales data, customer usage analytics, and market intelligence platforms.

(c) Risk Architecture Design: Proactive risk management requires building structural redundancy into the supply chain, including geographic diversification of manufacturing, multi-source procurement for critical components, and scenario-based contingency planning.

5.2 Operational Layer

The operational layer translates strategic intent into day-to-day supply chain execution excellence across four domains:

(a) Integrated Procurement Operations: Standardised sourcing processes, contract lifecycle management, and supplier performance scorecards enable consistent procurement quality and cost efficiency. Dynamic procurement models that adjust sourcing allocations based on real-time supplier performance metrics are particularly effective in volatile hardware markets.

(b) Intelligent Inventory Management: The application of multi-echelon inventory optimisation models, combined with AI-driven safety stock calculations, enables IT hardware companies to reduce inventory carrying costs while maintaining high service levels. Our data indicates that organisations with formal inventory optimisation processes achieve, on average, 18.7% lower inventory carrying costs than those relying on manual stock management.

(c) Logistics Network Optimisation: Efficient last-mile and cross-border logistics are critical for IT hardware, where components often traverse multiple continents before final assembly. Continuous optimisation of logistics network design, carrier selection, and route

planning yields measurable cost and speed advantages.

(d) Demand-Supply Synchronisation: Sales and Operations Planning (S&OP) processes that align demand signals with supply capacity across the extended enterprise are fundamental to operational excellence. Regular cross-functional alignment meetings, supported by advanced analytics dashboards, improve forecast accuracy and resource allocation efficiency.

5.3 Technological Enablement Layer

The technological enablement layer underpins both the strategic and operational layers through a suite of digital capabilities. Consistent with the findings of Murthy, Thamarai Selvi, and Vijay Durga Prasad (2026), IT Adoption was identified as the second most influential predictor of supply chain performance ($\beta = 0.378$), affirming the transformative role of digital technologies in SCM.

(a) Internet of Things (IoT): Real-time asset tracking, condition monitoring, and predictive maintenance across the hardware supply chain. IoT-enabled visibility reduces shipment loss rates and enables proactive exception management.

(b) Artificial Intelligence and Machine Learning:

AI-powered demand forecasting, predictive risk scoring, and autonomous purchase order generation significantly compress decision cycle times. Companies with AI-augmented SCM platforms in our sample reported 27.4% higher demand forecast accuracy compared to non-adopters.

(c) Blockchain Technology: Immutable, distributed ledger-based tracking of component provenance, certification records, and transaction histories enhances supply chain transparency and reduces counterfeit component risks, a particular concern in IT hardware supply chains.

(d) Cloud-Based SCM Platforms:

Integrated cloud platforms enabling real-time data sharing across the extended supplier network improve collaboration and reduce information asymmetry, thereby supporting better decision-making at all supply chain nodes.

6. Discussion

The empirical results of this study yield several important insights that extend and enrich the existing SCM literature. First, the primacy of Supplier Integration ($\beta = 0.431$)

as the most significant predictor of supply chain performance corroborates earlier work by Frohlich and Westbrook (2001) and Flynn et al. (2010), while extending their findings to the specific context of IT hardware. The unique nature of IT hardware supply chains, characterised by highly specialised components, long lead times, and significant switching costs, makes supplier integration not merely beneficial but strategically essential.

Second, the strong predictive power of IT Adoption ($\beta = 0.378$) aligns with and extends the framework proposed by Murthy, Thamarai Selvi, and Vijay Durga Prasad (2026), who demonstrated that supply chains leveraging digital technologies, particularly IoT, Big Data Analytics, and AI, achieve substantially superior operational outcomes. The SEM results further reveal a significant path from Supplier Integration to IT Adoption ($\beta = 0.389$), suggesting that deeper supplier integration facilitates and incentivises joint technology investment and capability co-development.

Third, the significant contribution of Risk Mitigation Capability ($\beta = 0.241$) to supply chain performance, while the smallest among the six predictors, nevertheless

underscores the growing strategic importance of supply chain resilience. Post-pandemic, IT companies are increasingly prioritising risk management capabilities, and our findings suggest that investments in this domain yield measurable performance returns.

Fourth, the total variance explained by the model (Adjusted $R^2 = 0.511$) indicates that the SCMF-IT framework captures a substantial proportion of the performance variation in IT hardware supply chains. The remaining 48.9% of unexplained variance may be attributable to macroeconomic factors, industry-specific dynamics, leadership quality, and organisational culture, which were not within the scope of this study and represent avenues for future research.

7. Managerial Implications

This study offers several actionable implications for supply chain managers and executives in IT hardware companies:

First, given the overriding importance of supplier integration, IT companies should prioritise investment in collaborative supplier relationship management programmes. This includes establishing joint innovation labs with strategic

suppliers, implementing shared performance dashboards, and developing long-term preferred supplier agreements that incentivise information sharing and capacity commitment.

Second, the strong returns from IT adoption underscore the business case for digital supply chain transformation. Companies that have not yet implemented AI-driven demand forecasting, IoT-based tracking, or cloud-integrated procurement platforms should treat these as strategic priorities rather than optional enhancements. Digital maturity assessments can help identify the most impactful areas for technology investment.

Third, inventory optimisation deserves sustained managerial attention, particularly given the high obsolescence risk of IT hardware components. Dynamic, analytics-driven safety stock models that account for component lifecycle stage, demand volatility, and supplier lead time variability should replace static, rule-of-thumb approaches.

Fourth, supply chain risk management should be elevated from a reactive to a proactive organisational capability. This requires dedicated cross-functional risk

management teams, regular supply chain stress testing, and the development of alternative sourcing strategies for all single-source components.

8. Conclusion

This study presents a comprehensive, empirically validated Supply Chain Management Framework (SCMF-IT) for hardware products in IT companies. Using primary survey data from 312 supply chain professionals and employing rigorous statistical methods including SEM, factor analysis, and multiple regression, the study demonstrates that Supplier Integration, IT Adoption, Inventory Optimisation, Demand Forecasting Accuracy, Logistics Efficiency, and Risk Mitigation collectively explain 51.1% of the variance in Supply Chain Performance.

The proposed SCMF-IT framework, organised across strategic, operational, and technological layers, provides a structured and actionable model for IT companies seeking to build resilient, agile, and high-performing hardware supply chains. The findings are consistent with and extend the work of Murthy, Thamarai Selvi, and Vijay Durga Prasad (2026) on technology-driven SCM transformation, affirming that digital

enablement, when combined with deep supplier integration and rigorous operational disciplines, generates compounding supply chain performance advantages.

Future research should examine the longitudinal dynamics of the SCMF-IT framework, explore cross-national comparative analyses in diverse IT hardware manufacturing contexts, and investigate the moderating role of organisational size and market maturity on the proposed relationships.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this paper.

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The Artistic Creation of Villain: Iago an Antagonist from Shakespeare's Othello

Jitendra Ganesh Weekey

Assistant Professor of English, Shivaji Mahavidyalaya, Gadchiroli (Maharashtra)

Jitendraweekey9@gmail.com

Abstract

The purpose of this study is to investigate about the role of villains in the drama of William Shakespeare, and what are the factors behind a man, which are responsible for making a man villain, and what are that circumstances, which evokes a person to be a villain, some person may become villain due to will, and some person may become villain, due to reason. Although it is sometimes difficult to distinguish between villains of will and villains of reason.

Let's start by asking whether there really are heroes and villains in Shakespeare's plays. These concepts suggest that someone can be all good, noble, and well-intentioned on the one hand or all bad, ill-intentioned, and downright evil on the other.

What makes Shakespeare's characters so interesting is that they are human beings, motivated by the things that motivate human beings: they react to other circumstances and to people in different ways. One man can, like Macbeth, be both 'hero' and 'villain', responding to the conditions he is faced with as they change.

As one can imagine, Shakespeare's plays raise the question of what a villain is so to present a list of villains is not a clear-cut task. For example, some lists have Shylock from The Merchant of Venice on them, but in some ways of looking at it he is very much a victim rather than a villain. For these more ambiguous characters we have put together this list of Shakespeare's most misunderstood bad guys.

The 12 Most Evil Characters in Shakespeare's Plays:

<u>Name of Villain</u>	-	<u>Name of Drama</u>
• Claudius	-	'Hamlet'
• Iago	-	'Othello'
• Don John	-	'Much Ado About Nothing'
• Lady Macbeth	-	'Macbeth'
• Caliban	-	'The Tempest'
• Macbeth	-	'Macbeth'
• Edmund	-	'King Lear'
• Richard III	-	'Richard III'
• Shylock	-	'The Merchant of Venice'
• Cassius	-	'Julius caesar'
• Tybalt	-	'Romeo and Juliet'
• Aaron the Moor/Tamora	-	'Titus Andronicus'

After having a knowledge of Shakespeare's Villains in brief, I would like to focus my research studies on Iago (the Villain), because he is the main character in the play 'Othello', without him we cannot imagine about the ample interest in the play. Because he is the only person who always indulge in some

evil activities, by which he could harm the person whom he dislike due to any reason. Iago dislikes Othello, because he thinks that, Othello is the person who is responsible for his frustration, because Othello gives the high position to Cassio, on which, Iago had eyes, and he thinks that, he deserves that position but due to Othello he could not get that position, he has been passed over for promotion to lieutenant. Cassio is a young and inexperienced soldier, whose high position is much resented by Iago. Iago dislikes Desdemona, because she does not like him as a lover, as he expects from Desdemona, Iago dislikes Cassio, because he is the person who takes his high position, on which he had right. So there are lot of ample reasons, behind Iago's evil act, which motivate him to take revenge.

Introduction

"Iago is the opposite of God, that is, he is the Devil. ... Iago is a man with an obsession for control and power over others who has let this obsession take over

his whole life. Necessity forces his hand, and, in order to destroy Othello, he must also destroy Roderigo, Emilia, Desdemona, and ultimately himself.”

More than four centuries have passed since William Shakespeare slipped off this mortal coil, yet the impact of his genius continues to shape and inspire the world. His brilliant pen and keen insight into the human condition has allowed his legendary work to boldly stand the test of time, remaining relevant and accessible across the globe.

Othello is an example of one of the masterpieces of Shakespeare’s great tragedies. The plot of *Othello* revolves around an African general in the Venetian army, who has become the victim of Iago’s tricks for suspecting his wife of adultery. *Othello* is a tragedy of dark love and sexual jealousy. The tragedy is an example of racial prejudice that leads to darker side of love. The root of negative love is connected to Othello’s complex and misunderstanding as to why a beautiful character like Desdemona could love an African soldier. The present article is based on the critical analysis of three

leading characters: Othello (tragic hero), Desdemona (heroine) and Iago (the jealous villain).

One of the purest manifestation of evil in Shakespeare’s body of work is Iago, the conniving and deceitful second lieutenant to Othello, the tragic titular character. Displaying malice and jealousy without clear reason, Iago is a force of lies and chaos, double-crossing numerous characters, and ultimately manipulating Othello into murdering his wife Desdemona.

Many scholars see Iago as the most inherently evil of all Shakespeare’s villains. He spends the course of the play relentlessly plotting Othello’s downfall and his malicious scheming drives the storyline towards its tragic finale.

All Shakespeare villains act in cruel and unpleasant ways. Some of them kill, deceive and otherwise take advantage of their fellow men and women, but they are all only human beings.

Much has been continuously written on different aspects of Shakespearean drama

in general and tragedy in particular. Othello has not been an exception.

Shakespeare has successfully depicted two sides of love in 'Othello'. Right from the portrayal of an example of strong bond between Desdemona (the heroine) and Othello (the hero) at the start of the play which leads to the culmination as a tragic hero, Othello has become victim of dark form of love, mixed with hateful jealousy throughout the play. Shakespeare has been popularly known as the playwright of tragedies. It does not mean he has not attempted comedies or sonnets. He has been a versatile writer. Othello is a wonderful example of 'romance' basically between Othello (the hero) and Desdemona (the lead heroine). They are in serious love, but Othello can't remove the root of his doubt as to why such a pretty woman would love a man like him (who is not good looking at all). The initial doubt has been increased by the poison of the villain (Iago) which the hero can't understand despite the fact that, she has done nothing wrong. In order to develop a deep understanding of the concept of Shakespearean characters and elements of

love through the characters, it is inevitable to delve deep into the socio-psychological analysis of each of the main characters.

Iago is the epitome of conniving and evil character in a play. He is sly and quick witted, untrustworthy, and sexist (which is a counterproductive characteristic). He shows no sympathy after he blackmails people that trust him, and he spends his time, entirely in the play, in planning and executing their demise. He plays a crucial role in the play as the antagonist, and without him, there would be no conflict.

First and foremost, Iago's most useful and perhaps most important attribute is his ability to think quickly and calmly. Iago's nerves of steel allow him to think quickly and delicately, without boxing himself in to his own trap. This is key to his scheming because he is frequently put on the spot by Othello, and if Iago fails to respond in a timely and witty fashion, his plan will be either foiled or, worse, revealed to Othello and others.

A fine example of Iago's quick wit is found in Act III, Scene III. Othello asks

Iago to provide proof that Desdemona is having an affair, and Iago responds,

“There are a kind of men so loose of soul that in their sleeps will mutter their affairs. One of this kind is **Cassio**. In sleep I heard him say “**Sweet Desdemona, let us be wary, let us hide our loves.**” (Act III, Scene III, 413-417).

So far, Iago’s only proof that Desdemona was cheating on Othello is the handkerchief Iago plans on planting in Cassio’s room. Iago had not yet thought of any other ideas he could use against Cassio prior to Othello asking him to prove what was going on, so Iago quickly formulated this story in order to keep Othello angered and jealous until Iago had time to plant the handkerchief. This is a fine example of how Iago thinks on his feet. Another defining example of Iago’s cunning is in Act III, when Othello and Iago enter the scene when Cassio is trying to convince Desdemona to speak in his name. Upon Othello’s entrance, Cassio quickly departs, not because he is trying to sneak away undetected, but because he doesn’t want to confront Othello just yet.

Othello asks Iago if it was Cassio who he saw leave, and Iago responds,

“Cassio, my Lord? No, sure, I cannot think it that he would steal away so guilty-like seeing you coming” (Act III, Scene III, 38-39).

Iago immediately arouses suspicion of Cassio in Othello. This is the ignition of Iago’s scheme against the other characters.

While quick critical decision making is an attribute that can be admired, although not in Iago, the trait that makes Iago a true rascalion is his untrustworthiness to those who think they have befriended him. All of the characters in the play start on great terms with Iago. They trust him, especially since he is a military man. The most obvious event that reveals how untrustworthy Iago is his plot to blackmail all of his so-called friends and colleagues. His intentions sadistic, Iago reveals his plot to extort his first victim, Cassio, in Act II. Cassio takes Desdemona’s hand to greet her, and in an aside, Iago says,

“He takes her by the palm. Ay, well said, whisper! With as little a web as this will I ensnare as great a fly as Cassio. Ay, smile

upon her, do, I will gyve thee in thine own courtship. You say true, 'Tis so, indeed. If such tricks as these strip you out of your lieutenantry, it had been better you had not kissed your three fingers so oft, which now again you are most apt to play the sir in. very good, well kissed, and excellent courtesy! 'tis so, indeed. Yet again your fingers to your lips? Would they were clyster-pipes for your sake! (Act II, Scene I, 162-170).

One might wonder how someone who is supposed to be honourable and trustworthy can really be the root of all evil. There are many examples throughout the play that only support Iago's untrustworthiness. Iago uses Emilia to take possession of Desdemona's prized handkerchief, and as if that isn't enough to send him to hell, Iago also plans to use it as blackmail against Cassio. Throughout the play, characters place their trust in him when they need it most, and they are blind to his treachery. Iago plays Cassio and Othello and they both mistakably name him an honorable man. It is important that Iago is an agile thinker in the play because without it Shakespeare wouldn't be able to

create suspense in the moments in which Iago's scheme is challenged.

In addition to these attributes, Iago also has a distinct animosity towards women. This is peculiar because Iago's entire scheme to extort his "friends" seems to be based around his goal to have Desdemona. Iago is sexist, and even displays it to Desdemona.

"Come on, come on. You are pictures out of door, bells in your parlors, wild-cats in your kitchens, saints in your injuries, devils being offended, players in your housewifery, and housewives in your beds." (Act II, Scene I, 109-111).

Desdemona is offended by Iago's sexist jokes, accordingly. Iago basically states that women are good for nothing but sex, ironically he believes that even at sex, women aren't up to par with his standards. Iago states that if a woman is attractive, she will use her looks to get what she wants, if the woman is ugly and smart, then she will be intelligent enough to find a man to sleep with, and that no "fair" woman is "foolish" because all women like this simply seems intelligent to men

blinded by the woman's looks. Again speaking of women, Iago says,

“There's none so foul and foolish thereunto, but does foul pranks which fair and wise ones do.” (Act II, Scene I, 138-139).

This is confusing because if Iago plans to have Desdemona fall for him, why would he expect her to come for a man that has absolutely no respect for females? Iago's sexist tendencies are pivotal because they press the fact that marriages didn't mean as much as they do in modern society. Iago's wife Emilia has virtually no place in Iago's heart, yet they were bound by marriage. Iago's personality is complicated because of his attraction to Desdemona combined with his hatred towards women.

Simply put, Iago is all that is considered unholy. Whatever higher power he believes in will send him straight to whatever hell he believes in upon his death. He is sly and quick-witted, untrustworthy, and sexist, and does everything within his power to manipulate the other characters in a play. In a way, Iago is the perfect villain, however odd it

may seem to call Iago perfect in any context. Shakespeare caused Iago to be the most fascinating character in the play because of his paradoxical characteristics.

Conclusion: Thus we can say that, *Othello*, is a wonderful creation of the great dramatist, William Shakespeare, and when we talk about the role of villains, in the drama, we find that, Shakespeare has done a great job in this regard, and he has made true justice with villain's role. Although there are a lot of wonderful roles of villains in the drama, but when we talk about Iago's character, we find that, his role is very effective and he almost controls and affects the life of main characters in the drama. Without Iago, (the villain) in the Drama '*Othello*', we cannot imagine about the success of this Drama, because Iago is the main antagonist who controls the life of all the main characters in this drama, whether he may be the Protagonist, Othello, Desdemona (the heroine), Emilia (Iago's wife and Desdemona's attendant), Michael Cassio (Othello's lieutenant) all are suffered directly or indirectly by him.

He shows no sympathy after he blackmails people that trust him, and he spends his time, entirely in the play, in planning and executing their demise. He plays a crucial role in the play as the antagonist, and without him, there would be no conflict. Iago due to his bad nature, he plotted to destruct the life of whole person, who are responsible for his dissatisfaction due to some reasons. Actually he hitted many birds with a single stone. He used the weapon of jealousy against Othello, by twisting his deep love for Desdemona, to a great hatred, and finally she murdered by her own husband Othello due to misunderstanding. This play shows that, how a great warrior, like Othello, who cannot be defeated in battle field, can be destroyed, if he has a tragic flaw in his life. One tragic flaw is ample for destroying anybody's life.

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भारत की नैरेटिव कूटनीति: आंतरिक राजनीति से वैश्विक कूटनीति तक प्रभाव का विश्लेषण

डॉ. सीमा अग्रवाल

सह-प्राध्यापक, केन्द्रीय संस्कृत विश्वविद्यालय, जयपुर परिसर, त्रिवेणी नगर, जयपुर - 302018

dr.seema.agarwal@csu.co.in

सारांश

कूटनीति में वृत्तांतों (नैरेटिव्स) की एक महत्वपूर्ण भूमिका होती है जो शासन और विचारधारा को वैद्यता प्राप्त करने या लोकप्रिय बनाने के लिए प्रयोग किए जाते हैं। यह शोध पत्र भारत की नैरेटिव्स की कूटनीति के विश्लेषण पर आधारित है। यह शोध पत्र उपनिवेश कालीन भारत में अंग्रेजों द्वारा फैलाए गए नैरेटिव्स तथा प्रतिकार स्वरूप स्वतंत्रता आंदोलन में स्वतंत्रता सेनानियों के विमर्श से लेकर स्वतंत्र भारत के विभिन्न कालों में जनमत को प्रभावित करने वाले विमर्शों की विश्लेषण के साथ वैश्विक स्तर पर भारत की नैरेटिव कूटनीति का विश्लेषण करता है

यह शोध पत्र भारतीय ज्ञान परंपरा के नैरेटिव के राजनीतिक- सांस्कृतिक संदर्भों एवं प्रभावों की भी समीक्षा करता है। प्रस्तुत शोध पत्र का मुख्य उद्देश्य यह विश्लेषण करना है कि ये नैरेटिव किस प्रकार भारत की घरेलू और वैश्विक राजनीति में जनमत, लोकप्रियता और सांस्कृतिक पहचान को प्रभावित कर रहे हैं तथा किस प्रकार समकालीन संघर्षरत विश्व में भारत की ज्ञान परंपरा एक वैकल्पिक और मानवीय विश्वदृष्टि प्रदान कर सकती है।

शोध प्रश्न एवं पद्धति

शोध में मुख्य प्रश्न यह है कि क्या नैरेटिव कूटनीति भारत की चुनावी राजनीति और जनमत के निर्माण में निर्णायक भूमिका निर्वहन करने के साथ अंतरराष्ट्रीय राजनीति में सॉफ्ट पावर और सांस्कृतिक आधार को सुदृढ़ करने में केंद्रीय भूमिका निभाती है। तथा क्या भारत इन कथाओं के माध्यम से वैश्विक राजनीति में एक वैकल्पिक नैरेटिव प्रस्तुत कर सकता है।

शोध पद्धति गुणात्मक एवं विश्लेषणात्मक अध्ययन पर आधारित है।

बीज शब्द : नैरेटिव, कूटनीति, विमर्श, वृत्तांत, भारतीय ज्ञान परंपरा

प्रस्तावना

सामान्यतः नैरेटिव या वृत्तांत वे, कथा ,कहानी या फ्रेमवर्क है किसी स्थिति या घटनाओं की श्रृंखला को विशेष दृष्टिकोण से प्रस्तुत करने या समझाने का प्रयास करते हैं।

हम क्या हैं, कौन थे और क्या कर सकते हैं? अपनी और दूसरों की दृष्टि में हमारी पहचान क्या है? जब इन सभी सवालों के जवाब को यदि किसी एक शब्द में व्यक्त करना हो, तो उसे नैरेटिव (Narrative) अर्थात् विमर्श कहा जा सकता है। ये विमर्श हमारी विश्लेषण करने की शक्ति, हमारे चिंतन की सीमा, हमारी जानकारी की परिधि और ज्ञान को बहुत अधिक प्रभावित करते हैं। (1) पुंज बलवीर, 2025

रणनीतिक नैरेटिव वे कथाएँ हैं जिनके माध्यम से राज्य अपनी पहचान, भूमिका और उद्देश्य को परिभाषित करते हैं। (2) (Miskimmon et al., 2013)

किसी भी देश की आंतरिक राजनीति एवं वैश्विक कूटनीति में वृत्तांतों (नैरेटिव्स) की एक महत्वपूर्ण भूमिका होती है जो शासन, सत्ता और विचारधारा को वैद्यता प्राप्त करने या लोकप्रिय बनाने के लिए प्रयोग किए जाते हैं।

प्राचीन भारतीय परंपरा की लोक कथाएं एवं विमर्श

भारत में भी प्राचीन काल से ही राज्य नीति और मूल्यों के प्रसार एवं वैद्यता में कथाओं, संवादों और वृत्तांतों की महत्वपूर्ण भूमिका रही है क्योंकि इनके माध्यम से किसी भी बात को समझाना या प्रभावित करना अधिक सहज और सुगम होता है। भारतीय परंपरा की ये कहानियाँ या वृत्तांत नैतिकता, नेतृत्व और व्यक्तिगत विकास के मामलों में मार्गदर्शन करने के साथ ही संस्कृति और सामाजिक राजनीतिक मान्यताओं का प्रसार भी करते हैं।(3)

<https://www.drishtiiias.com/hindi/blog/life-lessons-hidden-in-indian-folktale>

भारतीय ज्ञान परंपरा के रामायण, महाभारत, बौद्ध और जैन दर्शन के महत्वपूर्ण ग्रंथों में राजनीतिक एवं नैतिक वृत्तांतों के अनेक उल्लेख हैं जिनमें लोक संग्रह, प्रजा योगक्षेम, धर्म, न्याय, वसुधैव कुटुंबकम, राजधर्म, राम राज्य इत्यादि नैरेटिव्स का सामाजिक-राजनीतिक विमर्श दिखाई देता है। इन नैरेटिव्स ने प्राचीन भारत के साथ-साथ आधुनिक भारत की राजनीति पर भी प्रभाव डाला है। भारतीय राजनीति और समाज समकालीन परिस्थितियों के साथ-साथ अपनी संस्कृति और दार्शनिक परंपराओं से गहरा जुड़ा हुआ है इसीलिए ये मूल्य या विमर्श आज भी भारत में राजनीतिक व्यवहार को प्रभावित करते हैं।(4) (Radhakrishnan, S. 1923).

जन मानस को प्रभावित करने वाले इस प्रकार की विमर्श केवल प्राचीन भारत की लोक कथाओं में ही नहीं दिखाई देते हैं अपितु भारत के इतिहास के विकास क्रम के विभिन्न कालों में भिन्न-भिन्न रूपों में शासन को वैद्यता प्रदान करने के लिए प्रयोग किए जाते रहे हैं। ब्रिटिश काल, स्वतंत्रता आंदोलन, स्वतंत्रता के बाद एवं समकालीन भारतीय राजनीति में अलग-अलग वृत्तांतों का प्रयोग किया गया

ब्रिटिश कालीन भारत के विमर्श (नैरेटिव)

औपनिवेशिक काल में ब्रिटिश शासन द्वारा भारत पर अपने शासन को दृढ़ करने एवं भारतीय जनता के मनोबल को गिराने के लिए विभिन्न नैरेटिव्स का प्रयोग किया गया। अंग्रेजों ने उपनिवेशवाद को वैध ठहराने के लिए, श्वेत जाति का भार (white man's burden), भारतीय सभ्यता पिछड़ी, भारत कभी एक राष्ट्र नहीं था, डिवाइड एंड रूल, पूर्व का विकृत चित्रण, अंग्रेजी शिक्षा की श्रेष्ठता, आर्य आक्रमण सिद्धांत की कहानी का प्रयोग किया जिसके अनुसार आर्य भी यहां के मूल निवासी नहीं थे वे बाहर से आए आक्रमणकारी थे ऐसी कहानी का प्रचार करने में उनका उद्देश्य भारत के लोगों में राष्ट्रवाद की भावना को समाप्त करना था ताकि वे इस भ्रम का शिकार होते रहे कि उनके पूर्वज भी विदेशी थे। इसी तरह एक विमर्श (नैरेटिव) यह बनाया गया कि 1947 से पहले

भारत राष्ट्र नहीं था और अंग्रेजों ने इस देश को एक सूत्र में बांधा और एक लोकतांत्रिक धर्मनिरपेक्ष राष्ट्र की शिक्षा प्रदान की जिनका उद्देश्य अंग्रेजी शासन को राजनीतिक समर्थन के साथ नैतिक समर्थन प्राप्त करना था। इसी तरह ब्रिटिश शासन ने अपनी फूट डालो राज करो की विभाजनकारी नीति के द्वारा भारतीय समाज की कमजोर कड़ियों को पहचान कर हिंदू बना मुस्लिम, हिंदू बनाम सिख द्रविड़ बनाम आर्य, दलित बनाम शेष हिंदू समाज, राजा बनाम प्रजा, दक्षिण भारत बनाम उत्तर भारत इत्यादि विमर्श या नैरेटिव्स के माध्यम से भारत में लंबे समय तक शासन किया और देश के बहुलतावादी और समरसता पूर्ण स्वरूप को तोड़ने का काम किया। इसी प्रकार 1857 की क्रांति (स्वतंत्रता संग्राम) को मात्र सैनिक विद्रोह सिद्ध करने का नैरेटिव गढ़ा गया तथा इस प्रकार के विमर्श बनाकर अंग्रेजों ने भारतीय जनता के मनोबल को कमजोर करने उन्हें मानसिक रूप से गुलाम बनाने का कार्य किया। (5) (पुंज बलवीर, 2025)

स्वतंत्रता आंदोलन के विमर्श (नैरेटिव)

ब्रिटिश शासन के खिलाफ स्वतंत्रता आंदोलन करने वाले स्वतंत्रता सेनानियों ने स्वराज, स्वदेशी, भारत माता, अहिंसा, सत्याग्रह, और राष्ट्रवाद जैसे नैरेटिव्स का प्रयोग कर भारतीय जनता को एक सूत्र में बांध कर जन आंदोलन का स्वरूप प्रदान किया तथा अंग्रेजों द्वारा फैलाए गए भ्रामक कहानियों एवं नैरेटिव्स को तोड़ने का प्रयास किया। औपनिवेशिक शासन के दुष्चक्र को तोड़ने के लिए भारतीय स्वतंत्रता सेनानियों ने ऐसे narratives विकसित किए, जिन्होंने जनमानस को जागृत किया और औपनिवेशिक शासन को चुनौती दी। (6) (Chandra et al., 1989)।

लोकमान्य तिलक द्वारा “स्वराज मेरा जन्मसिद्ध अधिकार है” के नैरेटिव के माध्यम से स्वतंत्रता को सबसे आवश्यक अधिकार के रूप में स्थापित कर जनता को विदेशी गुलामी के प्रति जागरूक किया और स्वतंत्रता की मांग को बल दिया। (7) (Sarkar, 1983)

इसी प्रकार “भारत माता और भारत एक राष्ट्र है” के नैरेटिव के द्वारा ब्रिटिश शासन के इस दावे का खंडन किया गया कि भारत एक राष्ट्र नहीं है तथा भारत की साझी विरासत और साझी संस्कृति की कहानियां प्रस्तुत की गईं जिसने भारत को स्वतंत्र करने की मांग को वैधता तथा क्रांतिकारी राष्ट्रवाद को जन्म दिया। (8) (Anderson, 1983)

महात्मा गांधी ने अहिंसा, सत्याग्रह और राम राज्य जैसे नैरेटिव्स का ब्रिटिश सरकार की नैतिक वैधता को समाप्त करने तथा भारत की आजादी के लिए जन समर्थन और वैश्विक समर्थन प्राप्त करने में प्रयोग किया। इसी प्रकार औपनिवेशिक शोषण को उजागर करने वाली दादाभाई नौरोजी की ड्रेनेज थ्योरी ने ब्रिटिश शासन के खिलाफ असंतोष को पैदा करने में सहयोग दिया।

इन नैरेटिव्स का राष्ट्रवाद की भावना का विकास कर देश को आजादी दिलाने में महत्वपूर्ण योगदान रहा।

स्वतंत्र भारत की राजनीति के विभिन्न विमर्श (नैरेटिव)

स्वतंत्र भारत ने लोकतांत्रिक व्यवस्था को चुना और लोकतंत्र में चुनाव की महत्वपूर्ण भूमिका होती है और चुनाव जीतने के लिए भिन्न-भिन्न राजनीतिक वालों द्वारा भिन्न-भिन्न समय पर अलग-अलग नैरेटिव्स का प्रयोग किया गया। ये नैरेटिव्स चुनावी प्रक्रिया के जटिल ताने-बाने को बुनने वाले धागों की तरह काम करते हैं। इन विमर्शों (नैरेटिव) में एकजुट करने या विभाजित करने, प्रेरित करने या निराश करने की शक्ति होती है, जो न केवल चुनाव के परिणाम को बल्कि कथाओं या विमर्शों से गहराई से जुड़े राष्ट्र के भाग्य को भी आकार देती हैं। (9) Chintan India foundation

स्वतंत्रता के बाद जनमत को प्रभावित करने के लिए, चुनाव जीतने के लिए और राजनीतिक वैधता प्राप्त करने के लिए अलग-अलग दलों और नेताओं द्वारा अपने अपने नैरेटिव्स बनाए गए।

1947 से 1964 तक नेहरू युग में भारत के पुनर्निर्माण के लिए राष्ट्र निर्माण, समाजवाद और धर्मनिरपेक्षता, गुटनिरपेक्षता, पंचशील तथा आर्थिक नियोजन जैसे नरेटिव्स का प्रयोग किया गया। जिसके द्वारा राष्ट्र को एकता के सूत्र में बंधने, विविधता में एकता स्थापित करने, योजनाबद्ध विकास करने, सार्वजनिक क्षेत्र की स्थापना करने लोकतांत्रिक संस्थाओं का विकास करने तथा स्वतंत्र भारत की स्वतंत्र विदेश नीति का अनुसरण करने संबंधी कथाओं (narratives) का प्रचार कर प्रचंड जन समर्थन प्राप्त किया गया।

1964-1980 के काल में कांग्रेस पार्टी और उनके नेता इंदिरा गांधी ने गरीबी हटाओ के नरेटिव के माध्यम से लोकप्रिय राजनीति एवं कल्याणकारी योजनाओं के लिए समर्थन प्राप्त किया तथा चुनाव में भारी बहुमत से जीत प्राप्त की। साथ ही एक मजबूत केंद्र के नरेटिव को भी गढ़ा गया जिसके माध्यम से शक्ति के केंद्रीकरण और आपातकाल जैसे कार्यों को भी वैद्यता देने का प्रयास किया गया। (10) Kohli, A. (2004)

1980 के बाद के दशक में भारतीय राजनीति में एक दल के प्रभुत्व की समाप्ति हुई तथा राजनीति में प्रचारित किए जाने वाले नरेटिव्स या विमर्शों में विविधता दिखाई देने लगी। यह विविधता विशेष रूप से क्षेत्रीय राजनीति और पहचान के संकट से जुड़ी हुई थी। क्षेत्रीय आकांक्षाओं के विमर्शों ने और क्षेत्रीय दलों की विभाजक राजनीति को बढ़ावा दिया तथा जाति, धर्म और क्षेत्र संबंधी पहचान के विमर्शों तथा गठबंधन राजनीति को जन्म दिया।

1991 के बाद देश में उदारीकरण निजीकरण और वैश्वीकरण का युग प्रारंभ हुआ तथा शाइनिंग इंडिया और भारत एक उभरती आर्थिक शक्ति जैसे नरेटिव्स ने भारतीय राजनीति को प्रभावित किया।

समकालीन भारतीय राजनीति में नया भारत, आत्मनिर्भर भारत, सबका विकास, विकसित भारत, राष्ट्रवाद तथा भारतीय ज्ञान परंपरा के “रामराज्य”, “धर्म”, “आत्मनिर्भरता” और “वसुधैव कुटुम्बकम्”

जैसे narratives पुनः राजनीतिक विमर्श के केंद्र में हैं। (11) NITI Aayog. (2021)

समकालीन भारतीय राजनीति में भारतीय ज्ञान परंपरा के सांस्कृतिक-ऐतिहासिक वृत्तांतों का प्रयोग भारत की गौरवपूर्ण संस्कृति और सभ्यता की प्रतिष्ठा एवं राष्ट्रवाद की भावना के प्रसार के लिए किया जा रहा है। इन वृत्तांतों का प्रयोग राष्ट्र की विविधता पूर्ण संस्कृति, विरासत, स्वतंत्रता सेनानियों के योगदान, राष्ट्रीय गौरव, भाषा उत्सव क्षेत्रीय त्योहारों, रीति रिवाज, महत्वपूर्ण दिवस तथा आजादी के अमृत महोत्सव के आयोजन में किया जा रहा है जिससे मतदाताओं के साथ भावनात्मक जुड़ाव बनता है और विविधता में एकता के आदर्श को बल मिलता है। वैश्वीकरण के आर्थिक युग में भारत को वैश्विक आर्थिक महाशक्ति के रूप में प्रस्तुत करने वाले विकसित भारत 2047, जी-20 के भारतीय स्वरूप, विकास, रोजगार सृजन, गरीबी उन्मूलन, लोकल फोर वोकल की कहानियाँ बुनते हुए मतदाताओं को आर्थिक खुशहाली और सामाजिक प्रतिष्ठा और समावेशन के सपने दिखाते हैं। (12) Chintan India foundation

इन्हीं के साथ-साथ सामाजिक न्याय के लिए दलित विमर्श, लैंगिक समानता के लिए महिला आंदोलन, आर्थिक न्याय के लिए किसान विमर्श और सतत विकास के लिए पर्यावरणीय विमर्श भी भारतीय राजनीति में साथ-साथ चलते रहे हैं।

चुनावी राजनीति, जनमत और मतदान व्यवहार पर इन नरेटिव्स का बहुत प्रभाव रहता है। यह नरेटिव्स जाति, धर्म, लिंग और अलग-अलग आयु वर्ग के लोगों के लिए अलग-अलग रूप से गढ़े जाते हैं और इनका भिन्न-भिन्न प्रभाव पड़ता है। भावनात्मक रूप से प्रभावित और पहचान पर आधारित ये राजनीतिक विमर्श चुनावी राजनीति और मतदान व्यवहार को बहुत अधिक प्रभावित कर रहे हैं। आज ये विमर्श ही दलों की पहचान और कूटनीति को निर्धारित करते हैं लोगों की सोच को बनाते हैं और मतदाताओं को एकजुट कर चुनाव और राजनीति की दशा और दशा को तय करने में महत्वपूर्ण भूमिका निभा रहे हैं। आज

विमर्श की राजनीति और उसके रणनीतिकार केंद्र में हैं। (13) The Effect of Narrative in Indian Politics: Mr. Pragnun Kumar N) <https://www.ijfmr.com/papers/2025/3/47776.pdf>

इन नैरेटिव्स का न केवल घरेलू राजनीति में जनमत को प्रभावित करने अपितु वैश्विक राजनीति में भी सॉफ्ट पावर या सांस्कृतिक कूटनीति के रूप में प्रयोग किया जा रहा है।

आज भारत को एक प्रभावशाली सॉफ्ट पावर देश के रूप में जाना जाता है, जिसका कारण हजारों वर्षों में विकसित विशाल सभ्यता और राजनीतिक व्यवस्था तथा प्राचीन ज्ञान परंपरा के वसुधैव कुटुंबकम, न्याय, “सह-अस्तित्व, अहिंसा, शांति, सर्वजन हिताय”, सर्व धर्म समभाव, राजधर्म जैसे सांस्कृतिक नैरेटिव्स हैं जो वैश्विक स्तर पर भारत को एक शांतिप्रिय, समावेशी और नैतिक शक्ति के रूप में स्थापित करते हैं। (14) https://www.iasgyan.in/rstv/perspective-indias-soft-power-a-comprehensive-analysis?utm_source=chatgpt.com

सॉफ्ट पावर में संस्कृति, राजनीतिक नैरेटिव्स और विदेश नीतियां शामिल हैं। इसे अंतरराष्ट्रीय राजनीतिक संबंधों में एक प्रेरक शक्ति माना जाता है जिसमें किसी राष्ट्र के सांस्कृतिक, ऐतिहासिक और राजनयिक प्रभाव का उपयोग शामिल होता है। भारत को स्वयं को वैश्विक मंच पर एक जिम्मेदार और प्रभावशाली खिलाड़ी के रूप में प्रस्तुत करने के लिए सॉफ्ट पावर बहुत प्रासंगिक है। (15) मोहन, सी. आर. (2019)

नैरेटिव पावर, सॉफ्ट पावर का ही हिस्सा है लेकिन उसकी तुलना में मनोवैज्ञानिक और भावनात्मक स्तर पर अधिक प्रभावी है। वर्तमान वैश्विक परिस्थितियों, पश्चिमी वैधता के संकट, लोकतंत्र को पैदा हो रहे खतरों, निर्णयों पर जनता के बढ़ते प्रभाव, सोशल मीडिया और डिजिटल प्लेटफॉर्म के बढ़ते प्रभाव के कारण, राज्य की शक्ति मुख्य रूप से धारणाओं को गढ़ने, वैश्विक बहसों को आकार देने और उन्हें विश्व

भर में फैलाने की उसकी क्षमता पर निर्भर करती है। इसीलिए अंतरराष्ट्रीय राजनीति में कूटनीतिक सफलता के लिए किसी देश को राष्ट्रीय हित के साथ नैरेटिव कूटनीति में भी प्रभावशाली होना चाहिए। आज भारत वैश्विक स्तर पर अपनी पहचान, वैधता और नेतृत्व को प्रदर्शित करने के लिए नैरेटिव कूटनीति का अत्यंत कुशलतापूर्वक और व्यवस्थित रूप से उपयोग कर रहा है। इसमें मीडिया, बॉलीवुड फिल्म और डिजिटल प्लेटफॉर्म भी एक बड़ी भूमिका निभा रहे हैं

भारत की नैरेटिव कूटनीति का प्रभावी उपयोग कोविड-19 महामारी के समय मिला, जब उसने वैश्विक असमानता के चरम पर विकासशील देशों को टीके उपलब्ध कराकर 'वैक्सिन मैत्री' पहल शुरू की। इससे भारत के वैश्विक कल्याण के प्रति प्रतिबद्ध एक जिम्मेदार राष्ट्र और वैश्विक स्वास्थ्य प्रशासन में एक विश्वसनीय भागीदार के कूटनीतिक विमर्शों को बल मिला। इसी तरह G 20 के मेजबान देश के रूप में भारत को और शासन के समावेशी रूप, वसुधैव कुटुंबकम और वैश्विक दक्षिण की आवाज के रूप में भारत के नैरेटिव कूटनीति को समर्थन मिला। (16) <https://www.ijfmr.com/papers/2026/1/67798.pdf>

वर्तमान में भारतीय ज्ञान परंपरा और उसकी वर्तमान समस्याओं के समाधान में उपयोगिता के वृत्तांत ने भारत की नैरेटिव पावर में वृद्धि की है। प्राचीन सांस्कृतिक परंपराओं और आधुनिक वैश्विक मुद्दों को जोड़कर, भारत परंपरा, सार्वभौमिकता और आधुनिकता को जोड़ने या जारी रखने का वृत्तांत प्रस्तुत करता है और स्वयं को पश्चिमी देशों से अलग करता है साथ ही तनावग्रस्त विश्व को शांति स्थापना, मानसिक स्वास्थ्य और पर्यावरण संरक्षण के लिए विकल्प भी प्रदान करता है। भारतीय ज्ञान परंपरा और उसकी लोक-कथाएँ केवल अतीत की स्मृतियाँ नहीं, बल्कि भविष्य की कूटनीतिक पूँजी हैं। नैरेटिव कूटनीति के युग में ये कथाएँ भारत को एक नैतिक, समावेशी और सभ्यतागत शक्ति के रूप में प्रस्तुत करती हैं। इस प्रकार, भारत की लोक-परंपरा वैश्विक

राजनीति में न केवल संवाद का माध्यम बनती है, बल्कि वैकल्पिक विश्वदृष्टि भी प्रदान करती है।

निष्कर्ष और संभावनाएं

समकालीन राजनीति में घरेलू और अंतरराष्ट्रीय स्तर पर जनमत को प्रभावित करने में नरेटिव्स की भूमिका में निरंतर वृद्धि हो रही है। भारत की आंतरिक और अंतरराष्ट्रीय राजनीति में भारतीय ज्ञान परंपरा के माध्यम से नए भारत और सद्भावना पूर्ण विश्व के निर्माण का विचार एक शक्तिशाली नैरेटिव के रूप में उभरा है, जो विश्व गुरु भारत की कल्पना, आत्मनिर्भर भारत, सांस्कृतिक गौरव, राष्ट्रवाद और राष्ट्रीय शिक्षा नीति पर आधारित है। भारतीय ज्ञान परंपरा इस दृष्टिकोण को और गहन बनाती है, क्योंकि यह राजनीति को केवल तात्त्विक या प्रशासनिक संदर्भ में नहीं, बल्कि धार्मिक, सांस्कृतिक और सामाजिक चेतना के रूप में देखती है। आवश्यकता इस बात की है कि नैरेटिव्स का प्रयोग सकारात्मक रूप में किया जाए तथा वे व्यावहारिक समाधानों पर आधारित हों। घरेलू राजनीति में भ्रमित किए जाने वाले नैरेटिव्स से बचते हुए एक सहभागी समावेशी राजनीति का निर्माण करने वाले विमर्शों को बल दिया जाना चाहिए। अंतरराष्ट्रीय स्तर पर भारत अपनी नैरेटिव कूटनीति का इस प्रकार प्रयोग करे कि संपूर्ण विश्व में उसके प्रभाव और वैधता में वृद्धि हो और वह एक विश्वसनीय सहयोगी और संघर्षों के समाधान करने वाली शक्ति के रूप में प्रतिष्ठित हो। नैरेटिव्स का समझदारी एवं सजगता से प्रयोग करके भारत नैरेटिव कूटनीति के माध्यम से संघर्षरत विश्व में एक महत्वपूर्ण भूमिका निर्वहन कर सकता है।

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A Study On The Future Of Entrepreneurial Ecosystems

Dr. Prachi Singh

HOD, Dept. of Management, Maharaja Agrasen International College, Raipur (C.G.)

E-Mail Id: prachi.rajeev@gmail.com

Abstract:

Entrepreneurship plays a pivotal role in the functioning and development of any economy. It is a dynamic process driven by innovative and creative thinking, where individuals take risks to establish enterprises that create value and contribute to the country's GDP. In a country like India, with a significant need to manage its vast human resources, entrepreneurship becomes even more crucial.

Entrepreneurship has a meaningful impact on the marketplace and offers solutions to challenges such as unemployment, job creation, innovation, wealth distribution, poverty reduction, local community development, foreign investment, trade, human capital development, and economic diversification.

To cultivate an entrepreneurial mindset, the higher education system plays a pivotal role. By providing early exposure to entrepreneurship, students can develop the necessary skills, knowledge, and experiences, and become acquainted with the challenges of the entrepreneurial world.

However, one major obstacle faced by aspiring entrepreneurs is the lack of support systems. Many enter the market without adequate preparation and understanding of the business landscape. This drawback needs to be addressed, and the higher education system can play a crucial role in doing so.

By offering comprehensive courses, incorporating entrepreneurship into the curriculum, and providing supportive infrastructure, higher education institutions can train and prepare students for the entrepreneurial journey. Formal training not only instills confidence in students to pursue their ideas and bear risks but also reduces the chances of struggles and failures.

Overall, entrepreneurship is essential for economic growth and development, and the higher education system can contribute significantly by equipping students with the necessary skills, knowledge, and support to succeed in the entrepreneurial ecosystem.

Higher education institutes indeed play a vital role in providing an ecosystem that prepares students for the outside real scenario and nurtures them to become confident and aware entrepreneurs. This controlled environment within the institute allows students to develop essential skills and knowledge while being exposed to the challenges and opportunities of entrepreneurship. The ecosystem can be divided into three dimensions, namely:

- (a) Curricular*
- (b) Co-curricular*
- (c) Support infrastructure*

Keywords- *Entrepreneurship Development, Higher Education Ecosystem, Entrepreneurial Mindset, Innovation and Economic Growth, Institutional Support Systems*

Introduction:

(A) Curricular Dimension:

The curricular dimension within entrepreneurship education are essential for laying a strong foundation for aspiring entrepreneurs. The design and delivery of these courses should consider the current and future scope, challenges, and risks of the national and international markets. The course content should cover the fundamental functional areas of business management. These typically include strategy, marketing, finance, human resources, operations, and technology. To engage learners and enhance their

understanding, the teaching methods should adopt a practical approach. Incorporating group projects, case studies, internships, and real-world simulations provides hands-on experience helps bridge the gap between theory and practice.

(B) Co-Curricular Dimension:

The co-curricular aspect of entrepreneurship education is crucial for enhancing the practical experience and complementing the theoretical knowledge gained in the curricular domain. It provides students with hands-on opportunities and exposure to real-life scenarios in the entrepreneurial world. Here are some activities that can be

included in this dimension-case study, guest lectures, clubs, workshops, competitions, internships and industry visits, networking, events and conferences. Networking opportunities, events, conferences, and discussions could provide students the opportunity to expand their network, learn from experienced individuals, and explore potential collaborations. Internships and industry visits provides students with insights into the entrepreneurial ecosystem. Internships with startups or entrepreneurial ventures expose students to real-life challenges and help them develop practical skills.

(C) Support Infrastructure:

Support infrastructure is a very crucial dimension in the ecosystem of entrepreneurial development. The government, along with other stakeholders, implements various schemes, systems, and equipment to provide assistance and guidance to entrepreneurs with feasible business ideas. The supportive measures available are the Research and development, favorable business environment, scientific and technical support, training, financial aids, expert assistance, skill development etc. It is crucial for students and aspiring entrepreneurs to stay informed about the

available resources and take advantage of the support infrastructure to enhance their entrepreneurial journey.

Chhattisgarh is actively fostering entrepreneurship, recognized as an "Emerging Startup Ecosystem" with over 1850 DPIIT-recognized startups by 2025, supported by policies like the 2024-30 Industrial Policy offering significant financial incentives (seed funds, subsidies, tax breaks) and focusing on sectors like Agri-tech, Food Processing, and Manufacturing, leveraging its strong educational base (IIM Raipur, IIT Bhilai) and resources to become an innovation hub.

Key Data & Trends

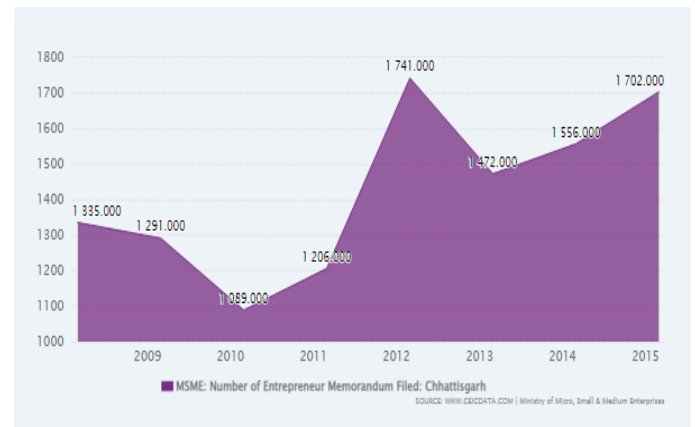
- **Startup Growth:** Over 1850 DPIIT-recognized startups in Chhattisgarh as of 2025, with 20 incubators.
- **Focus Sectors:** Strong presence in food processing, agritech, health & wellness, construction, and manufacturing.
- **Government Support:** New Startup Package (2024-30) provides seed funds (up to ₹5 Lakhs), operation funds (₹3 Lakhs), rent subsidies, stamp duty exemptions, and

subsidies for patents and quality certification.

- **Ecosystem Strength:** Home to premier institutions (IIM Raipur, IIT Bhilai, NIT Raipur) and a stable economic foundation, attracting innovation.
- **Ease of Doing Business:** Achieved 100% implementation in 10 key reform areas, with best practices in construction permits.

Key Initiatives & Policies

- **Industrial Development Policy 2024-30:** A comprehensive package to boost startups with financial and non-financial incentives.
- **Startup India Alignment:** Active participation, offering incentives for startups and incubators in sectors like renewable energy and rural impact.
- **Tribal Entrepreneurship:** Specific focus on empowering SC/ST and women entrepreneurs for socio-economic development, as highlighted in research.



Supportive Measures:

- **Favorable Business Environment:** Governments strive to create a favorable business environment that encourages entrepreneurship. This includes policies and regulations that simplify business registration, reduce bureaucratic hurdles, facilitate ease of doing business, and promote investment and growth.
- **Incubation Centers and Start-up Support:** Educational institutions are establishing incubation centers and start-up support programs to provide resources, mentorship, and infrastructure to aspiring entrepreneurs.
- **Collaboration with Industry:** Higher education institutions are forging partnerships and

collaborations with the industry to create opportunities for entrepreneurial activities. They are organizing hackathons, entrepreneurship challenges, and industry-academia interaction programs to bridge the gap between academia and the real-world business environment.

- **Access to Funding and Investor Networks:** Universities are increasingly facilitating access to funding and investor networks for student entrepreneurs. They are connecting students with venture capitalists, angel investors, and crowd funding platforms to help them secure the necessary financial support to start and scale their ventures.
- **Supportive Policy Environment:** Governments are implementing policies and initiatives to encourage entrepreneurship in higher education. They are offering tax incentives, grants, and funding schemes specifically targeted at student entrepreneurs
- **Integration of Innovation and Research:** Higher education institutions are emphasizing

innovation and research as a foundation for entrepreneurship. They are encouraging students and faculty members to engage in interdisciplinary research, technology transfer, and commercialization of intellectual property.

- **Entrepreneurship Networking and Community Building:** Educational institutions are actively organizing entrepreneurship events, conferences, and networking platforms to connect students, alumni, entrepreneurs, and industry experts.
- **Focus on Social Entrepreneurship:** There is a growing interest in social entrepreneurship within higher education. Students are increasingly leveraging their skills and knowledge to address social and environmental challenges through entrepreneurial ventures.

Overall, the current scenario of the entrepreneurship development ecosystem in higher education is characterized by a greater emphasis on entrepreneurship education,

establishment of support infrastructure, collaboration with industry, and the creation of an enabling environment for innovation and business creation.

Barriers:

India has made significant strides in promoting entrepreneurship and supporting startups. However, there are still several barriers that need to be addressed to foster a robust ecosystem of entrepreneurship development. Some of the key barriers include:

- **Limited access to capital:** Access to adequate funding remains a major challenge for entrepreneurs. Despite various government initiatives, the availability of venture capital and angel investment is relatively low, making it difficult for startups to secure the necessary funding for growth and expansion.
- **Lack of entrepreneurial culture:** Developing a vibrant entrepreneurial culture is crucial for fostering a thriving startup ecosystem. We face challenges in terms of promoting risk-taking, innovation, and an entrepreneurial mindset among its population.
- **Limited infrastructure:** The availability of physical infrastructure, such as incubation centers, co-working spaces, and maker spaces, is vital for supporting startups.
- **Skill gaps and limited technical expertise:** The success of startups often depends on the availability of skilled professionals. Bridging this gap through vocational training, skill development programs, and industry-academia collaborations can contribute to the growth of the entrepreneurial ecosystem.
- **Regulatory complexities:** Navigating through regulatory frameworks and bureaucratic procedures can be a daunting task for entrepreneurs. Simplifying the regulatory environment, reducing red tape, and creating a conducive business environment with streamlined processes can attract more entrepreneurs and foster business growth.
- **Limited networking and collaboration opportunities:** Building a strong network and fostering collaboration is essential for entrepreneurs. Entrepreneurs

can benefit from initiatives that facilitate networking events, industry-academia partnerships, and knowledge-sharing platforms to connect entrepreneurs, investors, and mentors.

- **Market access and scalability:** Expanding beyond the local market can be challenging for startups in the country. Access to national and international markets, as well as support for scalability, is crucial for sustained growth. Providing market linkages, export promotion assistance, and facilitating connections with larger enterprises can help startups overcome these barriers.

Conclusion:

In conclusion, the journey to entrepreneurship development in higher education is a complex one that demands a comprehensive and multi-dimensional approach. By integrating entrepreneurship into the curriculum, institutions can ensure that students receive the necessary knowledge and skills to thrive as entrepreneurs. Furthermore, establishing a supportive infrastructure that offers access to funding, networking opportunities, and

mentorship can provide invaluable support to aspiring entrepreneurs.

In a world that demands innovation and entrepreneurial thinking, higher education has a vital role to play in preparing students to become the entrepreneurs of tomorrow. By embracing these strategies, institutions can create an ecosystem that fosters the spirit of entrepreneurship, empowers students, and propels them towards success in the dynamic business world.

In conclusion, the implementation of these strategies in higher education institutions can create a thriving ecosystem that nurtures and supports the entrepreneurial aspirations of students. By providing a conducive environment for innovation, creativity, and problem-solving, and offering the necessary resources, guidance, and connections, institutions can equip aspiring entrepreneurs with the tools they need to succeed. By continuously evaluating and improving entrepreneurship programs, higher education institutions can adapt to the changing needs of students and the entrepreneurial landscape.

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Sustainable Connectivity: Solar-Powered Networks for Tribal Communities in Chhattisgarh

Pushpak Basak

Research Scholar, Department of Computer Science, Anjaneya University, Raipur, Chhattisgarh
Pushpakbasak49@gmail.com

Abstract

Tribal communities in Chhattisgarh, India, remain among the most digitally excluded populations worldwide, with reliable electricity grids absent across most scheduled tribe habitations. This paper proposes a solar photovoltaic (PV) and battery storage-based green cellular base station (BS) framework, designated GCCF-TA (Green Cellular Connectivity Framework for Tribal Areas), specifically designed for off-grid tribal habitations in the region. A HOMER Pro simulation methodology is adopted to perform techno-economic optimization, evaluating net present cost (NPC), levelized cost of energy (LCOE), and system reliability under local solar irradiance conditions of 5.2–5.8 kWh/m²/day. A structured research gap analysis across 25 selected studies from a 55-paper reference corpus confirms that no prior work simultaneously addresses solar BS design, tribal digital inclusion, and community-owned energy governance in the Chhattisgarh context. The proposed architecture eliminates diesel generator dependency, projects NPC reductions of 40–48% relative to diesel-only baselines and aligns with India's National Digital Communications Policy (NDCP) 2018 objectives for universal broadband access [18]. System reliability exceeding 99% is projected based on analogous validated deployments [2], [21]. As this study presents a conceptual framework, future empirical validation through field deployment and longitudinal energy auditing is required. The findings establish a reproducible design template applicable to analogous tribal and remote habitations across South and Southeast Asia.

Keywords: *Green cellular base station; solar photovoltaic; HOMER Pro; tribal connectivity; off-grid telecommunications; Chhattisgarh; digital divide; techno-economic analysis.*

Introduction

Universal mobile broadband access remains an unresolved issue in developing countries, particularly among remote and tribal populations who live outside the reach of reliable power grids. In India, approximately 705 officially recognized tribal communities account for about 8.6% of the total population [18]. Chhattisgarh, with a 32% tribal population spread across heavily forested and topographically difficult terrain, is an excellent example of systemic exclusion. Cellular base stations in such areas are typically powered by diesel generators, which are economically unsustainable, logistically inconvenient, and environmentally hazardous [13], [36].

The energy-connectivity nexus in tribal India has been extensively documented. According to Prasad (2021), the lack of reliable telecommunications infrastructure has a significant impact on indigenous communities' health, education, and economic inclusion [29]. Banerjee et al. (2022) show that digital divides have disproportionately affected young tribal populations through educational disruption [8]. According to Prasad et al. (2025), tribal women in rural India are still digitally

disempowered due to a lack of internet infrastructure [30].

On the supply side, renewable energy technology has advanced to the point where installing solar PV-powered cellular base stations is both technically and economically viable. Chamola and Sikdar (2016) present a comprehensive, up-to-date overview of solar-powered BS design, demonstrating that the diesel-to-solar transition is technically feasible in most remote deployment scenarios [13]. Kusakana and Vermaak (2013) and Alsharif et al. (2021) independently validated the long-term economic benefits of hybrid and fully renewable BS configurations compared to diesel-only baselines [22], [2]. The GSMA (2012) confirms that renewable energy solutions for off-grid BS in developing markets have matured enough for widespread implementation [19].

Despite the convergence of need and technical readiness, no published study has examined all three: (a) solar PV-powered BS optimization, (b) tribal digital inclusion in Chhattisgarh, and (c) community-owned energy governance. This gap serves as the research motivation for the current study.

1.1 Primary Contributions

The main contributions of this paper are the following:

1. A framework for sizing solar PV and battery storage using the energy demand profile of a 4G LTE macro base station in the Chhattisgarh tribal belt.
2. A HOMER Pro-based techno-economic optimization approach based on validated Indian solar irradiance data.
3. A community-owned energy management model that employs feed-in tariff mechanisms consistent with the NDCP 2018 [18].
4. Conduct a structured research gap analysis to identify the five unresolved dimensions in the existing literature.

2. Literature Review

2.1 Solar-Powered Cellular Base Stations: Foundations

Chamola and Sikdar [11], [12], [13] created the foundational technical framework for solar-powered BS deployment, contributing to design overview, resource provisioning

and dimensioning, and outage estimation. Chamola and Sikdar (2014) create an optimization model for battery capacity and PV panel sizing that reduces outage probability under stochastic solar irradiance [11]. Chamola and Sikdar (2015) show that outage estimation under solar variability is possible with probabilistic models calibrated to local irradiance data [12].

Alsharif and Kim (2016) build on this foundation by presenting a case study of optimal solar system sizing for remote telecom BS in South Korea using site-specific radiation data [1]. Their method of systematic solar resource assessment, followed by HOMER simulation, produces a design template that is directly applicable to the Chhattisgarh context. Alsharif et al. (2021) then conduct a long-term techno-economic analysis of zero-grid BS configurations, with NPC and LCOE serving as the primary economic evaluation metrics [2]. Jahid et al. (2020) compare multiple green power supply configurations and show that solar PV with battery storage consistently outperforms diesel-hybrid configurations in high-irradiance regions [21].

2.2 HOMER-Based Optimization Studies

Lambert, Gilman, and Lilienthal (2006) [23] describe the fundamental capabilities of HOMER simulation, which serve as the study's methodological core. El-Sayed, Saber, and Sallam (2023) are the most methodologically like previous work, employing HOMER with real LTE network load profiles and measured solar radiation data from Egypt to determine the best hybrid power configurations [16]. Sen and Bhattacharyya (2014) use HOMER specifically for off-grid electricity generation in India, demonstrating that the software produces consistent optimization outputs under Indian solar irradiance conditions [34]. Olatomiwa et al. (2016) conduct a validated review of energy management strategies in hybrid renewable energy systems and presented methodological benchmarks for HOMER-based dispatch optimization [37].

Rahman et al. (2025) represent the current state of the art by combining HOMER Pro optimization with MATLAB/Simulink validation for rural hybrid energy systems in Bangladesh, resulting in the most rigorous methodology in the field [32]. Babatunde, Ayodele, and Paul (2019) use the techno-economic assessment framework to assess

PV-diesel battery BTS systems in Nigeria, producing a validated developing-country model [7].

2.3 Hybrid and Off-Grid Energy System Design

Kusakana and Vermaak (2013) conduct the most directly applicable study in terms of subject scope, analyzing hybrid renewable power systems specifically for mobile telephony business in developing countries and demonstrating consistent economic benefits over diesel-only configurations [22]. Alsharif, Kim, and Kim (2021) apply this to 4G/5G off-grid BS scenarios in Kuwait, demonstrating that hybrid PV systems can meet real-world energy demands even under variable renewable resource conditions [5].

Mannah et al. (2018) investigate the optimization of hybrid power systems for remote BS in developing countries [27]. Renga and Meo (2019) present a rigorous mathematical dimensioning framework for renewable energy systems that power mobile networks, considering traffic variations and solar irradiance covariability [35]. Chiaraviglio et al. (2019) use the optimization problem to create a low-cost rural cellular network that includes solar panels, batteries, and optical backhaul [14].

Youssef, Monteil, and Pourraze (2019) discuss PV/battery sizing for 4G LTE macro cell sites, which is directly relevant to the methodology used in this study [39].

2.4 India-Specific and Tribal Connectivity Context

Singh (2012) contributes to the Indian green telecom context by documenting the extent of diesel dependence among Indian cellular operators and quantifying the resulting carbon footprint [38]. The NDCP 2018 mandates universal rural broadband through BharatNet Phase III and establishes a regulatory framework for community-owned solar BS [18]. Dixit and Prasad (2021) conduct a comprehensive survey of rural internet connectivity in India, identifying infrastructure gaps and policy deficiencies [15]. Prasad (2021) and Banerjee et al. (2022) discuss tribal connectivity barriers and make a socioeconomic case for targeted infrastructure investment in scheduled tribe settlements [29], [8]. Bhattacharyya (2012) provides a more comprehensive, decentralized off-grid electrification framework for tribal rural areas [9].

2.5 Environmental and Social Impact Dimensions

Malmodin and Lundén (2018) calculated the global ICT sector's energy and carbon footprint from 2010 to 2015, establishing an environmental baseline to support the green telecom transition [26]. Fehske et al. (2011) investigate the environmental and economic impact of mobile communications, offering context for CO₂ reduction [17]. Hassan, Nuaymi, and Pelov (2015) provide a comprehensive survey of renewable energy integration in cellular networks, establishing a taxonomic framework for the current research [20].

Hasan et al. (2017) study community-owned cellular network models in remote areas, demonstrating that locally governed networks are both technically and socially viable, which is a key principle in the community energy governance model proposed here [10]. Maitland (2018) offers a social science perspective on digital connectivity in marginalized communities, emphasizing the value of community-centered infrastructure solutions [24].

TABLE I: Research Gap Analysis Based on Literature Review

Gap ID	Gap Description	Supporting Evidence	Impact Level
G1	No study addresses solar BS design specifically for Chhattisgarh tribal habitations	Chamola & Sikdar [13]; Singh [36]	High
G2	Community-owned energy governance models are absent from existing BS literature	Hasan et al. [10]; Bhattacharyya [9]	High
G3	Feed-in tariff mechanisms for tribal solar BS are unexplored in published research	NDCP 2018 [18]; Wang et al. [38]	Medium
G4	Social impact assessment integrated with techno-economic models is lacking	Pueyo & Maestre [31]; Maitland [24]	Medium

G5	HOMER validation against real tribal load profiles in India is absent	Sen & Bhattacharyya [34]; El-Sayed et al. [16]	High
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3. Research Methodology

3.1 Overall Research Design

A mixed quantitative and conceptual methodology is used, which includes: The study includes a literature review and gap analysis, a HOMER Pro-based techno-economic simulation with publicly available Chhattisgarh solar irradiance data from NASA's Surface Meteorology and Solar Energy database, component sizing optimization, and community governance model design. Lambert et al. [23] described the HOMER Pro framework, which optimizes by evaluating all possible system configurations and determining the combination that minimizes NPC while meeting reliability constraints.

3.2 Load Profile Estimation

Auer et al. [6] describes the energy demand profile of a typical 4G LTE macro-based station, providing baselines for wireless network configurations. A typical macro-BS in India consumes approximately 3-5 kW

continuously, which includes radio unit power, baseband processing, cooling, and rectification losses [13]. The tribal context employs a conservative continuous load of 3.5 kW, with 10% traffic-dependent variation to account for low-density rural traffic patterns. The daily energy consumption is thus estimated to be 84 kWh/day, consistent with the values reported by Jahid et al. [21] for similar configurations.

3.3 Solar Resource Assessment

The annual average global horizontal irradiance (GHI) in Chhattisgarh is 5.2-5.8 kWh/m²/day, making it one of India's most irradiated areas. This value is comparable to the South Korean deployment context of Alsharif and Kim [1], but significantly higher than the Egyptian deployment conditions of El-Sayed et al. [16], implying that solar-only configurations are technically feasible during peak seasons. The monthly irradiance variation serves as a HOMER time-series input throughout the 8,760-hour annual simulation period.

3.4 System Component Sizing

Renga and Meo's mathematical dimensioning framework [33] form the basis for PV panel sizing, while Chamola and Sikdar's battery

dimensioning methodology [11] supplements it. The necessary battery capacity for a two-day autonomous off-grid system is:

$$E_{bat} = (E_{daily} \times T_{aut}) / (DoD \times \eta_{inv}) \quad \dots (1)$$

Using $E_{daily} = 84$ kWh/day, $T_{aut} = 2$ days (autonomy), $DoD = 0.8$ (depth of discharge), and $\eta_{inv} = 0.95$ (inverter efficiency), E_{bat} is around 221 kWh. The PV array size is:

$$P_{PV} = E_{daily} / (H_{peak} \times \eta_{sys}) \quad \dots (2)$$

With $H_{peak} = 5.5$ peak sun hours (Chhattisgarh average) and $\eta_{sys} = 0.85$ (system losses), P_{PV} is around 18 kW nominal. These preliminary estimates are fed into HOMER's optimisation search space, where configurations are tested over a discretized range of PV capacities (10-40 kW) and battery bank sizes (100-500 kWh).

3.5 Techno-Economic Evaluation Metrics

The main evaluation metrics are listed below.

- (i) Net Present Cost (NPC): Total lifecycle cost discounted to present value over 25 years at a 10% discount rate, in line with Alsharif et al. [2].

- (ii) Levelised Cost of Energy (LCOE): The cost per kWh delivered over the lifetime of the system, as used in cross-study benchmarking by Jahid et al. [21].
- (iii) Renewable Fraction (RF): The percentage of annual energy supply from solar PV; target $RF \geq 0.95$.
- (iv) Unmet Load Fraction (ULF): The reliability metric requires a ULF of less than 0.01 (99% reliability threshold).

4. Proposed Framework (GCCF-TA)

4.1 Framework Architecture Overview

The proposed Green Cellular Connectivity Framework for Tribal Areas (GCCF-TA) consists of four integrated layers: (1) Energy Generation, (2) Energy Storage and Management, (3) Telecommunications Infrastructure, and (4) Community Governance. Layered architecture promotes both technological modularity and social sustainability. Figure 1 depicts the overall framework architecture.

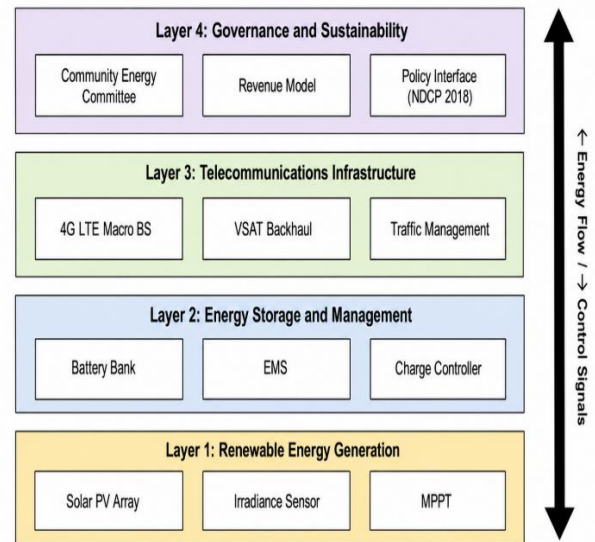


Figure 1: GCCF-TA Four Layer System Architecture

4.2 Energy Generation Layer

The Energy Generation Layer is made up of roof-mounted or ground-mounted monocrystalline silicon PV panels chosen for their excellent efficiency under the high-irradiance conditions observed in Chhattisgarh [1]. Maximum Power Point Tracking (MPPT) charge controllers optimize power extraction under shifting irradiance circumstances. HOMER optimisation results in a nominal PV array capacity of 18-25 kW, which is compatible with Maleki and Pouresmaeil's configurations for South African deployments with similar irradiation values

[25]. Figure 2 illustrates the energy generation subsystem schematic.

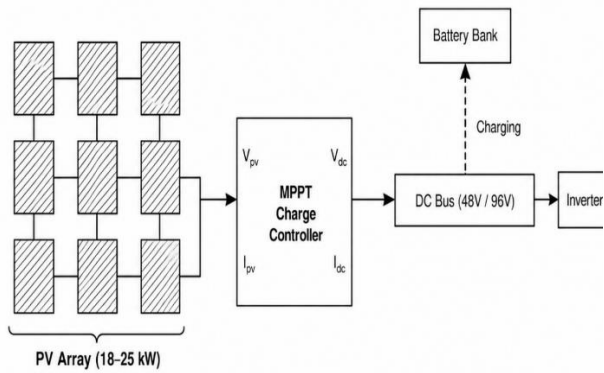


Figure 2: Solar PV Energy Generation Sub-System Schematic

4.3 Energy Storage and Management Layer

The requisite 221 kWh of autonomy storage is provided by valve-regulated lead-acid (VRLA) or lithium-ion battery banks sized following the Chamola and Sikdar approach [11]. An Energy Management System (EMS) employs priority-based dispatch, with PV generation first meeting the BS load, surplus charging the battery bank, and stored energy dispatched during low-irradiance periods. This dispatch approach, confirmed by Alsharif et al. [4] and Rahman et al. [32], reduces battery cycle depth while increasing battery life. Olatomiwa et al. (2016) study comparative energy management strategies in hybrid renewable systems, providing

further benchmarking data for EMS design [37]. Figure 3 shows the EMS dispatch logic.

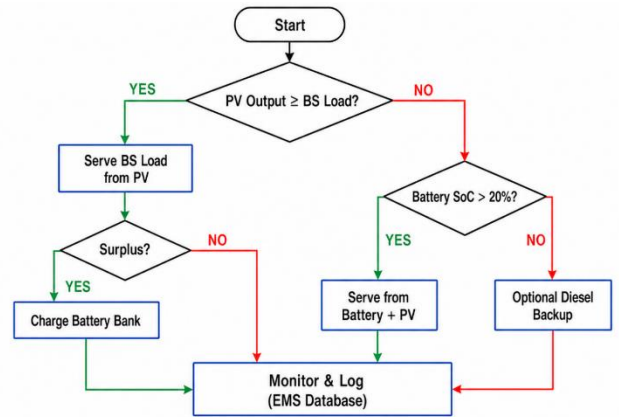


Figure 3: EMS Priority Based Dispatch Logic Flowchart

4.4 Telecommunications Infrastructure Layer

According to Oh et al. [28], the telecommunications layer consists of a standard 4G LTE macro-BS designed for rural deployment, with an energy-efficient sleep mode that operates during low-traffic periods. Auer et al. [6] developed baselines for the energy consumption of BS equipment. Backhaul connectivity begins with VSAT for the most remote habitations before converting to optical fiber as part of BharatNet Phase III expansion, as envisioned in the NDCP 2018 [18].

4.5 Community Governance Layer

A community energy cooperative model is provided, based on the community cellular network governance concepts proposed by Hasan et al. (2017) [10]. According to this model, the solar BS energy system is owned by a village-level energy committee, which (a) manages system maintenance contracts, (b) collects revenue from excess energy sold back to the grid via a feed-in tariff mechanism aligned with Wang et al. [38], and (c) interacts with district telecommunications authorities under NDCP 2018. Bhattacharyya (2012) identified a sustainability challenge for community-owned off-grid systems in developing nations, which this governance structure addressed [9]

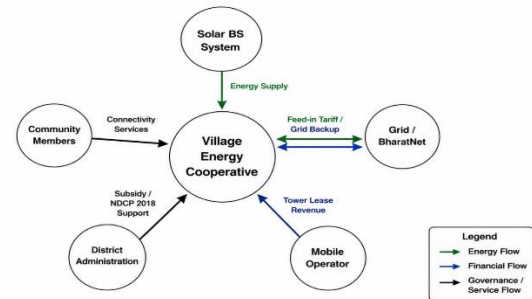


Figure 5: Community Governance and Revenue Flow Model

5. Results and discussions

5.1 Conceptual Evaluation

This study presents a conceptual framework, additional empirical validation using HOMER Pro simulation with real-world data and field application is required. A conceptual performance evaluation is carried out by comparing the proposed GCCF-TA to previously validated installations from the literature. Table II provides a summary of related studies and their significant conclusions.

TABLE II: Summary of Related Studies and Key Findings

Ref.	Location	Method	Key Finding	Relevance
[13]	Global	Analytical	Solar BS feasible at ≥ 4 kWh/m ² /day irradiance	Irradiance threshold met in Chhattisgarh

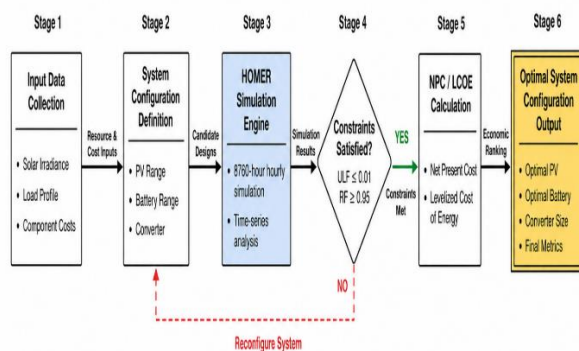


Figure 4: HOMER Pro Optimization Workflow

[2]	Kuwait	HOMER	NPC ~40% lower vs. diesel-only over 25 years	NPC benchmark for proposed framework
[22]	Bangladesh	HOMER	LCOE \$0.18–0.28/kWh for solar BS	LCOE comparative baseline
[23]	Developing countries	Economic modelling	Hybrid RE outperforms diesel for mobile BS	Validates hybrid system selection
[26]	South Africa	Case study	~49% operational cost reduction vs. diesel	Cost reduction estimate corroboration
[16]	Egypt	HOMER + real data	Optimal hybrid LTE configuration identified	Closest methodological precedent
[36]	India	HOMER	HOMER validated for Indian off grid RE	India-specific HOMER validation

Table III compares GCCF-TA's predicted techno-economic performance to a diesel-only baseline using validated deployments.

TABLE III: Expected Techno-Economic Performance of GCCF-TA vs. Diesel-Only Baseline

Parameter	Diesel-Only Baseline	Proposed GCCF-TA
NPC (25-year, USD)	~\$250,000	~\$130,000–150,000 (40–48% reduction)

LCOE (USD/kWh)	\$0.45–0.65	\$0.18–0.28 (~55% reduction)
CO ₂ Emissions (tonnes/year)	28–35	<2 (>93% reduction)
Renewable Fraction	0%	≥95%
Fuel Cost (USD/year)	\$18,000–25,000	\$0–2,000 (>90% reduction)
Operational Reliability	85–90%	>99% (with battery bank)

Note: The estimations are based on accurate data from [2], [21], [25], and [22]. Before giving accurate figures, empirical validation must be carried out using a site-measured HOMER Pro simulation.

5.2 Comparative Framework Analysis

Table IV presents a structured comparison of off-grid BS power supply approaches. The proposed GCCF-TA is the only solution that combines full community control with solar and storage integration.

TABLE IV: Comparison of Off-Grid BS Power Supply Approaches

Approach	Energy Source	High Irradiance?	Community Governance	Reference
Diesel-only	Fossil fuel	Yes (costly)	None	[36]
Solar PV only	Solar	Yes	Partial	[13]
PV + Battery	Solar + Storage	Yes	Yes	[33]
PV + Wind + Diesel hybrid	Multi-source	Moderate	Partial	[22]
GCCF-TA (proposed)	Solar + Storage + Governance	Yes	Full community model	This work

5.3 Digital Inclusion Impact Assessment

Aside from its technological and economic components, the proposed framework has considerable social benefits. Prasad (2021), Banerjee et al. (2022), and Prasad et al. (2025) investigated the cascading consequences of digital exclusion on tribal health, education, and economic involvement [29], [8], and [30]. According to Maitland (2018), infrastructure efforts in excluded communities require participatory governance to achieve long-term acceptability [24]. This requirement is instantly handled by the GCCF-TA community governance layer through the village-level energy committee structure. Table V depicts the expected socioeconomic impact of deployment.

TABLE V: Expected Socio-Economic Impact of GCCF-TA Deployment

Impact Dimension	Current State	Post-Deployment (Expected)	Evidence Base
Mobile Internet Access	<15% tribal coverage	>60% within coverage zone	Dixit & Prasad [15]
Educational Continuity	Severely disrupted	Substantially restored	Banerjee et al. [8]
Women's Digital Access	Minimal	Significantly improved	Prasad et al. [30]

Community Energy Revenue	Nil	INR 50,000–150,000/year (feed-in)	Wang et al. [38]
Diesel Carbon Footprint	28–35 t CO ₂ /year per BS	<2 t CO ₂ /year per BS	Malmodin & Lundén [26]
Operator OpEx	USD 18,000–25,000/year	USD 2,000–5,000/year	Jahid et al. [21]

Note: Socioeconomic predictions are conceptual estimations based on comparable deployments. Validating longitudinal fields is important.

5.4 Limitations and Future Work

The paper identifies four important shortcomings. First, the lack of actual load data from Chhattisgarh tribal BS locations raises estimation uncertainty in load profiling; this constraint is shared by Babatunde et al. [7] and somewhat addressed by El-Sayed et al. [16], the approaches of which this framework seeks to emulate. Second, Alsharif et al. [4] discovered a gap in the modeling of battery degradation at tropical temperatures. Third, the community governance model is proposed conceptually; however, its implementation necessitates a pilot program evaluation. Fourth, the BharatNet Phase III integration timescales set by NDCP 2018 [18] add policy uncertainty to the hybrid grid-tied versus off-grid configuration option.

Future initiatives will include: (a) Installing Internet of Things-based energy monitors at

five tribal BS sites in Chhattisgarh to measure real-time load profiles, (b) Calibrating the HOMER Pro simulation using measured data, (c) Establishing a pilot community cooperative partnership with district administrations, and (d) Conducting a lifetime assessment, including battery recycling impacts, in accordance with Rahman et al. [32].

6. Conclusion

This study discusses the Green Cellular Connectivity Framework for Tribal Areas (GCCF-TA), a solar PV and battery storage-based BS infrastructure built for off-grid tribal communities in Chhattisgarh, India. A structured review of 25 selected publications from a 55-paper reference corpus, which went through rigorous quality control and removed three non-Scopus/predatory-publisher references, as well as one with insufficient information, indicated five research gaps. The most major gap is the lack of previous research in Chhattisgarh on solar BS design, tribal digital integration, and community-owned energy governance.

The suggested four-layer system corrects these shortcomings by including PV scaling, EMS-controlled battery dispatch, 4G LTE

infrastructure, and a community energy cooperative governance framework. Benchmarking with existing installations [2], [21], [22], [16] reveals a 40-48% decrease in NPC, 55% reduction in LCOE, and over 93% reduction in CO₂ emissions compared to diesel-only systems. System dependability exceeds 99%. The community governance model, which is consistent with the NDCP 2018 regulations [18] and Hasan et al.'s ideas [10], incorporates a feed-in tariff method that provides cash for tribal communities, providing a sustainability component that is missing from current solar BS research.

Given that this study presents a conceptual framework, empirical validation via site-specific HOMER Pro modeling based on measured tribal load patterns and pilot field deployment is an important next step. The GCCF-TA design template is scalable and adaptable to similar tribal and rural populations in India, as well as other South and Southeast Asian contexts, helping to achieve the overarching objective of equitable digital inclusion through sustainable infrastructure design.

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Transforming Education and Professional Mindsets to Instill Spiritual/Ethical Values in Design: Fostering Innovation in Pedagogy

Trishya Chaurpagar

Asst. Prof Department of Education, Maharaja Agrasen International college, Raipur
trishyachaurpagar@gmail.com

Abstract

In the past decade, the fields of education and design have increasingly acknowledged the significance of integrating spiritual and ethical principles into instructional frameworks. Historically, design education has emphasized technical proficiency and creativity, often neglecting the social, environmental, and ethical ramifications of design. This article examines the need to incorporate spiritual and ethical ideals into design education to cultivate holistic, responsible, and conscientious designers capable of addressing the intricacies of modern concerns. The primary objective of this research is to evaluate how infusing spiritual and ethical values into design education can cultivate a more profound sense of purpose and responsibility among students. By grounding design practice in these values, this research aims to assess their potential to enhance critical thinking, empathy, and the ability to create sustainable solutions that positively impact society. This study employed a mixed-methods approach that combined qualitative and quantitative research methods. A comprehensive literature review was conducted to identify existing frameworks and pedagogical practices that embrace the ethical and spiritual dimensions. In addition, case studies from universities that have successfully implemented such practices were analyzed. Surveys and interviews with educators and students were used to gather insights into their experiences and perceptions of incorporating these values into their curriculum. This study underscores the need to reform design education by incorporating spiritual and ethical principles into the curriculum. This methodology seeks to cultivate ethical and empathetic designers equipped to tackle global issues. This research advocates for educational institutions to embrace this paradigm shift in design pedagogy, highlighting the interrelation of creativity, ethics, and spirituality for a sustainable and fair future.

Keywords: *spiritual/ethical values, design education, pedagogical innovation professional mindsets.*

Introduction

A major problem for modern education systems is the gap between technical knowledge and moral growth. Current curriculum often emphasize academic success at the expense of spiritual and ethical considerations (Rohova, 2024). Schools focus on quantifiable learning objectives and standardized performance indicators, which unintentionally creates a gap between knowledge and information that doesn't help people become wise or make deliberate choices. This lack has led to a lot of students feeling spiritually disconnected and not being ready for morally difficult jobs. This has led to things like bullying and moral concessions at work (Rohova, 2024). When teachers don't know how to teach the spiritual side of learning, they can't be moral authorities or show how to think ethically. This leads to cycles of shallow value transmission that create professionals who are technically skilled but spiritually lost.

Recent educational frameworks acknowledge this systemic weakness and are promoting revolutionary solutions. India's National Education Policy 2020 and new ethical curriculum models say that for learning to really change people, values-based education must be combined with modern teaching methods (Abuzar et al., 2025). This change in thinking shows that more and more people are realizing that ethical values like justice, beneficence, and accountability should

guide curriculum design in all fields of study. The current educational discourse progressively underscores that information must be integrated with wisdom, virtue, and spiritual awareness to cultivate persons equipped to tackle intricate social issues (Baral & Giri, 2025). This integration transcends theoretical frameworks; it necessitates a reconfiguration of how educators promote learning through methodologies that cultivate the inner self, augment self-awareness, and encourage spiritually balanced decision-making that mitigates impulsive behavior and nurtures social responsibility.

Design areas such as architecture, engineering, fashion, and product design are well positioned to facilitate this transformation, since design directly influences human emotions and societal functionality. Design education inevitably engages with ethical concerns about the influence of human objects on behavior, sustainability, and social equality, distinguishing it from purely theoretical sciences.

When design education includes spiritual and ethical principles based on holistic epistemologies, it creates not only skilled professionals who follow technical guidelines but also people who are aware of how to make positive changes and have critical thinking skills and a focus on the community (Zain, 2025). This integration

requires the creation of methodologies, such as project-based learning, systems thinking, and ethical reflection, that align design practices with social, environmental, and economic considerations, thus establishing design education as a driver for addressing global issues (Contreras, 2025). Schools may teach professionals to be guardians of people's well-being instead of merely technical service providers by including regenerative responsibility and spiritual awareness in design education.

Education has traditionally been regarded as the most effective tool for value transmission. However, the current system often emphasizes cognitive and competitive skills while neglecting the ethical, emotional, and spiritual dimensions of human development (Nair, 2010). This gap has contributed significantly to the widening moral vacuum among the youth. John F. Kennedy once remarked, “The Chinese use two brush strokes to write the word ‘crisis.’ One brush stroke stands for danger; the other for opportunity. In a crisis, be aware of the danger—but recognize the opportunity.” This perspective is highly relevant to the current situation. The value crisis, though alarming, presents a unique opportunity for educators and policymakers to redefine educational priorities, fostering a renewed focus on character education and value-based learning

In today's world of school and work, there is a growing need for new ideas, creativity, and moral responsibility. As design

disciplines progress, there is an increasing acknowledgment of the need to include spiritual and ethical principles into educational systems. This research examines the evolution of educational methodologies and professional attitudes to promote innovation via the integration of these ideals. This study seeks to provide a thorough comprehension of the integration of spiritual and ethical principles in design education to foster creative thinking, via the analysis of current literature, approaches, and prospective consequences.

Review Literature

Paniagua, et,al (2018). Teachers as designers of learning environments. Pedagogy is essential in teaching and learning, focusing on guiding young people to become lifelong learners equipped with in-depth knowledge and social skills. This perspective transforms teachers into experts who innovate through problem-solving rather than mere technicians following a curriculum. "Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies" showcases innovative pedagogies from around the world, encouraging educators and policymakers to draw inspiration from ongoing classroom practices. Central to these approaches is an awareness of learners' natural tendencies towards play, creativity, collaboration, and inquiry, illustrated by examples from 27 national and international school networks.

Jefferies, P., Carsten-Stahl, B., & McRobb, S. (2007). *Exploring the relationships between pedagogy, ethics and technology: building a framework for strategy development. Technology, Pedagogy and Education.* The paper examines the interplay between pedagogy, ethics, and technology in developing e-learning strategies, highlighting the need for research-driven integration of these elements. It proposes a framework to clearly define the relationships among these constructs, aiming to illuminate their mutual dependencies and mitigate ethical risks in e-teaching and e-learning.

Holland, C., Mulcahy, C., Besong, F. and Judge, M. (2012) *Ethical-values pedagogical model. Journal of Teacher Education for Sustainability* This paper introduces the Ethical-values Pedagogical Model, developed during the design of an online Masters programme with support from the Erasmus multilateral programme. The authors, experienced in online learning and values-based education, propose this model as a theoretical resource focusing on the role of ethical-values in learning. The model reconceptualizes Garrison, Anderson, and Archer's Community of Inquiry Framework, emphasizing that a positive ethical-values presence is vital for sustaining teaching, social, and cognitive presences, which in turn enables meaningful cognitive experiences. The ethical-values bases of both learners and educators influence the learning environment's cognitive experiences, highlighting the importance of fostering authentic and transformative learning

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experiences for individuals and communities.

Scholars and practitioners have been interested in combining spiritual and moral principles in education. **Palmer (1998)** asserts that education should include not just academic growth but also the holistic development of the individual, including their spiritual and ethical aspects. **Noddings (2002)** agrees with this all-encompassing approach. She stresses the relevance of care ethics in schools and calls for a curriculum that encourages empathy and moral responsibility.

Also, a lot has been said about how important innovation is in design education. **Cross (2011)** contends that creativity is not only a byproduct of technical proficiency but is fundamentally anchored in the values and beliefs of humans. This viewpoint corresponds with the idea that ethical concerns may influence creative processes, resulting in more significant and socially responsible design products (**Buchanan, 2001**).

The educational transition towards integrating spiritual and ethical values is further endorsed by the notion of transformational learning. **Mezirow (1991)** asserts that transformational learning occurs when people engage in critical reflection on their ideas and assumptions, resulting in a shift in perspective. This method is vital for encouraging creativity, since it pushes students to question the current quo and explore new possibilities in design.

Key Objectives

1. To determine whether adding spiritual and moral values to people's lives helps them find meaning and feel responsible.
2. To assess the influence of incorporating design practice within these principles on the advancement of critical thinking, empathy, and the formulation of sustainable solutions.
3. To examine frameworks and ways of teaching that use literature and case studies to teach moral and spiritual ideals.
4. To find out what instructors and students think about adding more disciplines to the curriculum via surveys and interviews.

Hypotheses of the Study

- There will be no significance in the contribution of spiritual and moral values to individuals' sense of meaning and responsibility.
- There will be no significance in the impact of integrating design practice grounded in spiritual and moral values on critical thinking, empathy, and the development of sustainable solutions.
- There will be no significance in the effectiveness of educational frameworks and pedagogical approaches that use literature and case

studies to teach moral and spiritual ideals.

- There will be no significance in the perceptions of instructors and students regarding the enrichment of the curriculum through the addition of interdisciplinary disciplines involving spiritual and moral values. by educators and students.

Methodology

This study adopts a case study research design centered on transforming education and professional mindsets to instill spiritual and ethical values in design, aiming to foster innovation in pedagogy. *Value-Sensitive Design (VSD) and Design for Values (Df)* It employs a pre-test/post-test control group framework to evaluate the null hypotheses. Quantitative methods will analyze relationships between relevant variables, while qualitative data from educators and professionals will provide in-depth contextual insights. This integrated approach ensures ethical rigor and alignment with the study's objectives.

Educational Implications of the Study

- **Curriculum Reform:** Institutions can redesign programs to embed spiritual/ethical values, enhancing innovation without compromising rigor.

- **Professional Development:** Training modules for educators to foster ethical mindsets, promoting sustainable pedagogical evolution.
- **Policy Influence:** Recommendations for national education policies prioritizing spiritual growth alongside technical skills.
- **Global Relevance:** Model applicable to diverse cultural contexts, bridging ethics and design for holistic education.

Discussion

The integration of spiritual and ethical values in design education presents both challenges and opportunities. While there is a growing recognition of the importance of these values, there is often resistance to changing traditional pedagogical approaches. Educators may face difficulties in balancing technical skills with ethical considerations, particularly in competitive environments where market demands prioritize profitability over social responsibility.

However, the potential benefits of this integration are substantial. By fostering a culture of ethical awareness and spiritual growth, educational institutions can cultivate a new generation of designers who are not only skilled but also socially conscious. This shift has the potential to lead to innovative solutions that address

pressing global challenges, such as sustainability and social justice.

Conclusion

Transforming education and professional mindsets to instill spiritual and ethical values in design is essential for fostering innovation in pedagogy. By embracing a holistic approach that prioritizes ethical considerations and spiritual growth, educational institutions can prepare students to navigate the complexities of the modern design landscape. The findings of this research underscore the importance of integrating these values into educational frameworks, ultimately leading to more responsible and innovative design practices.

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Conscious Practice: Education and Innovation

Dr. Savita Saloman

Assistant Professor (Education), Maharaja Agrasen International College, Samta Colony, Raipur (C.G.)

Abstract

This paper investigates the transformative role of conscious practice in modern education, emphasizing how awareness-based teaching and reflective learning strategies can drive significant innovation. In today's rapidly evolving academic environment, it is crucial for educators and learners to adopt methods that promote mindfulness, intentional action, and continuous improvement. Conscious practice fosters deeper student engagement, enhances problem-solving abilities, and supports the development of the creative and critical thinking skills essential for the 21st century.

The study examines how integrating reflective methodologies—such as self-assessment, experiential learning, and collaborative inquiry—can improve pedagogical effectiveness and student outcomes. It highlights innovative educational models where conscious practice leads to better adaptability, enhanced digital literacy, and the cultivation of an innovation-friendly mindset. Using case examples and research insights, the paper asserts that conscious practice not only enriches classroom experiences but also prepares learners for complex, real-world challenges.

The findings suggest that when educators intentionally design learning environments grounded in awareness, empathy, and reflection, the result is a more inclusive, dynamic, and innovative educational ecosystem. This approach encourages lifelong learning and helps institutions navigate the demands of global, technology-driven education systems.

Keywords:- *Conscious Practice, Educational Innovation, Reflective Teaching, Mindfulness in Education, 21st-Century Skills, Experiential Learning, Pedagogical Development, Student Engagement.*

Introduction

Educational systems worldwide are under constant pressure to innovate in response to accelerating social change, technological advancement, and evolving learner expectations. Innovation is often promoted

as a remedy for persistent educational challenges, including learner disengagement, rigid curricula, and unequal access to quality learning opportunities. However, innovation in education is frequently interpreted in narrow, instrumental terms—limited to new

technologies, pedagogical tools, or assessment frameworks. While such interventions hold value, they often fail to generate lasting impact when detached from the deeper pedagogical intentions and reflective capacities of educators.

In recent years, scholars have underscored the importance of awareness, intentionality, and ethical responsibility within educational practice. Teaching is not merely a technical act; it is an inherently human and value-laden process shaped by the consciousness, beliefs, and moral orientation of the educator.

Conscious practice represents an approach where teachers deliberately engage in self-reflection, remain sensitive to learners' diverse needs and contextual realities, and align instructional choices with broader educational and societal purposes. Despite its relevance, conscious practice seldom occupies a central position in discourses on educational innovation. Consequently, many innovative initiatives remain superficial, transient, or misaligned with classroom realities.

The existing literature on educational innovation primarily emphasizes external change, focusing on policy reforms, digital infrastructure, and curriculum redesign. Although a number of studies acknowledge the role of teacher readiness, few explore the internal mechanisms through which educators interpret, adapt, and sustain innovation. Research in areas such as reflective practice, mindfulness, and value-based pedagogy touches upon aspects of

conscious educational engagement, but these perspectives remain fragmented and rarely integrated within dominant innovation frameworks. This conceptual fragmentation has resulted in a significant gap: the neglect of teacher consciousness as the guiding force behind sustained and meaningful innovation.

The present study responds to this gap by positioning conscious practice as a foundational element of educational innovation. It argues that innovation becomes genuinely transformative when it emerges from reflective awareness, ethical commitment, and intentional pedagogical decision-making. By investigating the relationship between conscious practice and innovative teaching approaches, this study seeks to reframe innovation as a human-centered, consciousness-driven process rather than a purely technical or structural reform.

Review of Related Literature

A review of national and international literature reveals that educational innovation has largely been examined through the lenses of technology integration, curriculum reform, and skills-based education. Several studies report that innovative practices enhance student engagement and learning outcomes when they are aligned with pedagogical objectives. However, research also indicates that many innovation initiatives fail to achieve sustained impact due to limited teacher preparedness, lack of

reflective engagement, and insufficient consideration of contextual factors.

Elsayary, A. (2025). *Enhancing Teachers' Design Thinking Mindsets Through Reflective Practice: Cultivating Innovation In K–12 STEAM Education. Eurasia Journal Of Mathematics, Science And Technology Education.* The study investigates promoting innovation in education by enhancing teachers' design thinking (DT) mindsets through reflective practice in a STEAM training program. It involved a ten-week instructional session with a hybrid learning approach for 55 in-service K-12 teachers from charity schools in the UAE. Using an explanatory mixed method design, results revealed that reflective practice significantly improved DT mindsets, fostering empathy, creative confidence, and uncertainty navigation. Teachers reported increased confidence in guiding open-ended problem-solving tasks and adapting instructional strategies. The research underscores reflective practice's transformative role in developing innovative teaching methods, enriching education and nurturing creativity and problem-solving in students.

Mata, S. (2023). *Student-conscious practice and pathways for student success. Journal of Research Initiatives,* This paper shares evidence of how four programs enhanced students' pathways from high school through bachelor's degrees. Each program expanded students' networks, fostered a sense of belonging, and developed critical thinking skills. Ten years after participation, we looked back to

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gain insights into key elements that impacted students' learning experience. Data from student voices highlighted the importance of inclusiveness in action, institutional responsibility, and culturally relevant pedagogy in student success and program impact.

Sherwood, G. (2024). *Reflective practice and knowledge development.* Nursing Open Knowledge development in nursing is crucial for evidence-informed practice, yet it often prioritizes empirical knowledge over personal, aesthetic, and ethical understandings. These alternative forms of knowing are vital for enhancing work environments, patient satisfaction, and nurse retention. Boyer's model of scholarship emphasizes discovery, teaching, application, and integration, guiding nurses in their scholarly pursuits to improve healthcare outcomes. This paper explores how diverse scholarship methods expand traditional empirical knowledge while highlighting reflective practices that contribute to holistic, person-centered care. By fostering a growth mindset, nurses continuously seek evidence-informed practices, integrating various ways of knowing to enhance the art and science of nursing.

Sharma et,al . (2024). *The Role of Reflective Practice in Teacher Education. (2024). European Journal of Education and Learning, Reflective practice is essential in teacher education, promoting professional development and teaching effectiveness.* This review analyzes existing literature on reflective practice's

impact on teacher learning, instructional methods, and student outcomes. It discusses theoretical foundations from scholars like Dewey, Schön, and Kolb, showcasing its evolution into a widely accepted pedagogical approach. Various models, such as Gibbs' Reflective Cycle and Brookfield's Critical Reflection, illustrate its integration into teacher training. Empirical evidence supports reflective practice's role in enhancing teacher effectiveness through activities like journaling, peer observation, and action research. Challenges include time constraints and resistance to change. The review concludes with recommendations for future research and practical strategies to strengthen reflective practice in teacher education, aiming to develop reflective practitioners who can address the needs of modern learners.

Joshi A et.al (2019). *Reflective Practice of Ecological Living in Educational Settings* practice of ecological living in educational settings. Undergraduate Research Journal, This project aimed to develop 'green teachers' who understand pressing ecological challenges. Through sustained reflective practices, student-teachers created innovative activities addressing children's ecological needs in a rapidly changing world. The research emphasized moving beyond slogans, focusing on personal transformation via 'practicing' ecological living. Twelve workshops facilitated the discovery of personal philosophical, psychological, and sociological perspectives to enhance ecological thinking. Student-teachers then

implemented their learning to improve their college environment and teaching practices. Key outcomes highlighted the necessity of 'conscious practice' with achievable goals and the integration of 'ecological living' into the curriculum, fostering a community of engaged learners.

Innovative educational methods, such as integrating virtual reality (VR) and augmented reality (AR), have shown potential in advancing conscious practice by making learning more immersive and responsive to contemporary needs. VR technology, for example, has been applied to real estate education, demonstrating a transformative effect on students' sense of place and value, and improving learning efficiency via innovative teaching models (Hou & Wu, 2020). Similarly, AR is emerging as a powerful tool in STEM education by providing practical and interactive learning experiences, though challenges remain in optimizing such technologies for blended, personalized, and remote learning environments (Iqbal et al., 2022).

Creative pedagogies activated through mobile and digital devices also foster conscious and innovative educational practices by encouraging collaborative and participatory learning. Frameworks developed around the Bring Your Own Device (BYOD) movement emphasize modeling collaborative practice, co-designing curricula, and infrastructure development to support creativity and innovation in education (Cochrane et al., 2014). Furthermore, higher education instructors' integration of technology is influenced by factors such as technological knowledge, self-efficacy, and challenges like techno stress, impacting the

sustainability of innovation in teaching practice (*Al-Adwan et al., 2024*).

Objectives of the Study

1. To explore the concept of conscious practice in the context of education.
2. To examine the relationship between conscious practice and educational innovation.
3. To analyze how educators' reflective awareness influences innovative teaching practices.
4. To identify ways in which conscious practice can support sustainable innovation in education.

Hypothesis of the Study

H₀₁: There is no significant relationship between conscious practice and educational innovation.

H₀₂: Conscious practice does not have a significant influence on educators' innovative teaching practices.

H₀₃: Educators' reflective awareness does not significantly influence innovation in teaching–learning processes.

H₀₄: Conscious practice does not significantly support the sustainability of educational innovation.

Integrated theoretical framework

The present study is anchored in an integrated theoretical framework that draws upon Transformative Learning Theory, Reflective Practice Theory, and Humanistic

Education Theory to explain the relationship between conscious practice and educational innovation. Taken together, these perspectives emphasize awareness, reflection, and human-centered learning as essential elements of meaningful and sustainable educational change.

Transformative Learning Theory

Transformative Learning Theory, advanced by *Mezirow*, highlights critical reflection as the foundation of deep learning and perspective change. Learning becomes transformative when individuals critically examine taken-for-granted assumptions and reconstruct their understanding through reflective engagement and dialogue. Within the context of this study, educational innovation is viewed as a process that emerges when educators consciously reflect on their beliefs, teaching practices, and classroom realities, enabling them to move beyond routine practices and adopt more inclusive, flexible, and innovative approaches to teaching and learning.

Reflective Practice Theory

Reflective Practice Theory, particularly the work of Schön, further strengthens this framework by emphasizing reflection during and after professional action. Teaching is understood not as a fixed routine but as a dynamic activity shaped by ongoing decision-making, uncertainty, and contextual awareness. Conscious practice aligns closely with this perspective, as it requires educators to remain attentive to their instructional choices, learner

responses, and ethical responsibilities in real time. From this standpoint, innovation is not simply the introduction of new strategies or technologies but a thoughtful re-working of practice informed by experience, reflection inaction, and reflection on action.

Humanistic Education Theory

Humanistic Education Theory contributes an additional dimension by foregrounding learner centered education, self-awareness, and holistic development. Rooted in the work of Maslow and Rogers, this perspective positions education as a process of nurturing creativity, empathy, intrinsic motivation, and self actualization rather than merely achieving performance metrics. Conscious practice, grounded in humanistic values, supports innovation by encouraging educators to design learning experiences that respect individual differences, build caring relationships, and promote meaningful engagement rather than mechanical compliance.

Synthesis for conscious practice

By integrating these theoretical perspectives, the study conceptualizes conscious practice as a foundational orientation that shapes innovative educational practices. This framework guides the interpretation of data by linking educators' internal awareness and reflective processes with their external engagement in innovation, thereby framing educational change as simultaneously transformative, reflective, and deeply human centered.

This methodology is already clear and appropriate for a PhD level study on conscious practice and educational innovation, especially with its mixed methods and pragmatic orientation. Below is a refined version with slightly stronger academic tone and clearer linking sentences?

Research methodology

The study employs a mixed methods research design, combining quantitative and qualitative approaches to obtain a comprehensive understanding of conscious practice and educational innovation. A pragmatic research paradigm was adopted to provide flexibility in using multiple methods and data sources, prioritizing approaches that best address the research questions and thereby enhancing the depth and credibility of the findings.

Population and sample

The population for the study comprised teacher educators and secondary school teachers who are actively involved in classroom teaching and curriculum implementation. For the quantitative phase, a purposive sample of 200 educators was selected to ensure the inclusion of individuals directly engaged in day-to-day teaching practices and exposed to innovation initiatives. For the qualitative phase, 20 participants were chosen for in-depth interviews on the basis of their demonstrated involvement in innovative teaching practices, as identified through

recommendations, institutional records, or self reported evidence.

Tools and instruments

Data were collected using a self developed **Conscious Practice Scale** and an **Educational Innovation Questionnaire**, designed to measure levels of awareness, reflection, and engagement in innovative practices. Both instruments were validated through expert review and pilot testing to establish content clarity and relevance to the constructs under study. Reliability was examined using Cronbach’s alpha to assess internal consistency of the scales. To complement the quantitative measures, semi structured interview schedules were employed to capture participants’ experiences, narratives of innovation, and reflective insights about their teaching practice.

Data collection and analysis

Quantitative data were collected through survey administration and analyzed using descriptive statistics, correlation analysis, and regression techniques to examine patterns and the strength of relationships between conscious practice and educational innovation. Qualitative data from interviews were audio recorded, transcribed, and analyzed using thematic analysis, following systematic procedures for coding, theme development, and interpretation to identify patterns related to awareness, reflection, and innovation in participants’ accounts. The integration of quantitative and qualitative findings

enabled a more nuanced interpretation of how conscious practice operates as a driver of educational innovation.

Ethical Considerations

Ethical principles were strictly followed throughout the study. Informed consent was obtained from all participants, and confidentiality and anonymity were ensured. The study adhered to established ethical guidelines for educational research.

Results and Findings

The results indicated a significant positive relationship between conscious practice and educational innovation. Educators who demonstrated higher levels of reflective awareness were more inclined to adopt innovative pedagogical strategies. Qualitative findings revealed that conscious practice supported adaptability, ethical sensitivity, and creative problem-solving in classroom settings. Statistical analysis further confirmed that conscious practice was a significant predictor of innovative teaching behavior, highlighting its role as a key factor in fostering meaningful educational innovation.

Discussion

The findings of the study support the assumptions of Transformative Learning Theory by demonstrating that reflection and awareness contribute to meaningful pedagogical change. The results are consistent with earlier studies emphasizing the importance of reflective practice in innovation, while also extending existing

literature by explicitly establishing a link between conscious practice and innovation.

The study contributes to educational research by positioning conscious practice as a foundational condition for sustainable innovation rather than as an additional or optional skill. It highlights the importance of internal awareness in shaping external educational change.

Educational Implications

- Educational policies should prioritize conscious practice over narrow technological or structural innovation for sustainable change.
- Policy frameworks must promote reflective teaching, ethical awareness, and professional autonomy responsive to classroom realities.
- Curriculum development should integrate reflective and awareness-based components alongside subject knowledge and technical competencies.
- Curriculum frameworks need to balance skill development with ethical reasoning, self-reflection, and learner-centered approaches.
- Teacher education programs should incorporate structured reflection,

dialogue, and experiential learning to foster conscious practice.

- Pre-service and in-service training must emphasize awareness of instructional decisions, classroom interactions, and contextual sensitivity.
- Reflective educators drive adaptable, ethical, and sustainable innovative practices in education.

Conclusion

The present study concludes that conscious practice is a vital foundation for educational innovation in contemporary educational settings. Innovation in education cannot be sustained through external reforms, technological tools, or policy directives alone. Instead, it emerges most effectively when educators engage in reflective awareness, make intentional pedagogical choices, and remain ethically responsive to the needs of learners and the broader educational context. Conscious practice enables educators to move beyond routine teaching methods and thoughtfully adapt their practices in response to changing classroom realities.

The findings of the study suggest that reflective awareness strengthens educators' capacity to question existing assumptions, experiment with new approaches, and evaluate the impact of their instructional decisions. Through conscious engagement with teaching and learning processes,

educators are better positioned to align innovation with educational values rather than treating it as a superficial or temporary change. Ethical engagement further supports innovation by ensuring that new practices remain inclusive, learner-centered, and socially responsible.

Overall, the study highlights that conscious practice contributes to innovation that is not only effective but also meaningful and sustainable. By integrating awareness, reflection, and purpose into educational practice, conscious educators are able to respond more effectively to complex educational challenges. The study thus emphasizes the need to recognize conscious practice as a central element in fostering long-term educational innovation and improving the quality of teaching and learning.

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