Journal of Research and Development

A Multidisciplinary International Level

Referred and Double Blind Peer Reviewed, Open Access Journal

Journal of Research and Development

A Multidisciplinary International Double Blind Peer Reviewed Refereed International Research Journal

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JOURNAL PARTICULARS

Name of Journal	JOURNAL OF RESEARCH AND DEVELOPMENT
Frequency	Monthly : Jan to Dec (12 issues per year)
ISSN	2230-9578
Publisher	Dr. Ramesh V. Bhole
Chief Editor	Dr. Ramesh V. Bhole
Copy right	Journal of Research and Development
Starting Year	January 2010
Subject	Multi-Disciplinary
Review Process	Double Blind Peer
Language	English, Hindi, Marathi, and other Indian Constitutional Languages.
Publication Format	Print
Access	OPEN ACCESS
License	Creative Commons (CC BY-NC-SA 4.0)
Phone No.	+91 93256 65856, +91-8888454089
Email	jrdrvb.org@gmail.com
Journal Website	https://jrdrvb.org
Registered office Address	'Ravichandram' Survey No-101/1, Plot, No-23, Mundada Nagar, Jalgaon, Maharashtra, India
Admin. Office Address	'Ravichandram' Survey No-101/1, Plot, No-23, Mundada Nagar, Jalgaon , Maharashtra, India
Printing	**Amitsons Digital Copiers** 106 and 110, Paras Chambers 1st Floor, Near Laxmi Narayan Theatre, Above Bank Of India, Swargate-411042

JOURNAL OF RESEARCH AND DEVELOPMENT

A Multidisciplinary International Double Blind Peer Reviewed Refereed International Research Journal

Journal of Research and Development

Peer Reviewed International, Open Access Journal.
ISSN : 2230-9578 | Website: https://jrdrvb.org

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Original Article

Sustainability and Development in SAARC Nations

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Abstract

The South Asian Association for Regional Cooperation (SAARC) nations—Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka—face complex challenges in balancing rapid economic growth with sustainable development imperatives. The region is characterized by high population density, resource scarcity, poverty, inequality, and environmental degradation, while also offering opportunities for innovation, renewable energy, and regional cooperation. This paper explores the historical context of SAARC, defines sustainability in its social, economic, and ecological dimensions, and examines development paradigms, key issues, and case studies of successful initiatives. It highlights political instability, economic disparities, and cultural barriers as major obstacles to sustainability, but also underscores opportunities for cooperation, technological innovation, and international support. Policy recommendations emphasize integrating sustainability into national frameworks, strengthening regional partnerships, and fostering community-led conservation. The study concludes that while challenges are formidable, collaborative approaches and effective governance can guide SAARC nations toward achieving the Sustainable Development Goals (SDGs) and ensuring long-term prosperity.

Keywords: Sustainability; Sustainable Development; SAARC; Regional Cooperation; Renewable Energy; Environmental Degradation; Social Inequality; Resource Scarcity; Policy Frameworks; International Organizations.

Introduction

The South Asian Association for Regional Cooperation (SAARC) comprises seven member states: Afghanistan, Bangladesh, Bhutan, the Maldives, Nepal, Pakistan, and Sri Lanka. Since its establishment, the continent has experienced rapid population growth, urbanization, and industrialization. These trends, coupled with rising living standards and income levels, have led to the overexploitation of natural resources and environmental degradation. Furthermore, the South Asian region is vulnerable to climate change impacts, such as sea-level rise, erratic rainfall patterns, and changing temperature regimes. Despite these challenges, there are numerous economic opportunities in the region, underpinned by youthful populations, digital technology advancements, and global economic integration. Embracing these opportunities is crucial for achieving sustainable development goals.

Indicators of a sustainable development pathway include robust economic growth that creates dignified employment; investments in infrastructure, human capital, and technology synthesis; inclusive growth ensuring equitable benefits; reduction in extreme poverty and malnutrition; and significant improvements in access to essential services (Sahoo et al., 2016).

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How to cite this article:

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However, the current development model for Afghanistan, Bangladesh, Bhutan, the Maldives, Nepal, Pakistan, and Sri Lanka is fundamentally problematic. Sustaining the present growth trajectory, characterized by excessive natural resource consumption, will inevitably lead to environmental collapse. Immediate measures to decouple growth from environmental harm are necessary to maintain momentum without inflicting irreversible damage on life-support systems (Alauddin, 2002).

Historical Context of SAARC

The South Asian Association for Regional Cooperation (SAARC) consists of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. Founded in 1985, the organization aims to promote regional cooperation and address common socio-economic and environmental challenges. Its objectives include accelerating economic growth, social progress, and cultural development in the member countries, while promoting mutual trust and understanding.

Since its establishment, SAARC has become the most prominent regional organization in South Asia. The 14th SAARC summit in 2007 emphasized enhancing regional cooperation to address development challenges, particularly poverty and the environment. Therefore, development has become a key issue within the organization (Pulla et al., 2018).

Sustainability Defined

Sustainability remains subject to various interpretations, from broad concepts of being able to maintain something indefinitely to specific usages requiring additional clarifications (Hasan, 2017). The 1987 World Commission on Environment and Development defines sustainable development as fulfilling the needs of the present without compromising the ability of future generations to meet their own needs, with emphasis not only on conserving natural resources but also on ensuring fair distribution, efficiency, and preservation of essential natural foundations. Sustainable development therefore must meet the basic needs of the poor in ways that emphasize environmental sustainability, social values, community participation, and grassroots involvement (A. Gentry, 1995).

Historical analysis of the SAARC region reveals widespread poverty, deprivation, and acute environmental degradation, accompanied by an exploding population, declining per capita availability of natural resources, and high rates of unemployment. These features constrain development potential and threaten the feasibility of sustainable development. Natural resources constitute the backbone of all economic development; weak and vulnerable resource bases undermine a development strategy, while a poorly managed natural resource base jeopardizes economic growth and human well-being because the livelihood of a large majority of the poor remains directly dependent on the resource base. These observations outline the development policy and management challenges in SAARC nations.

Development Paradigms in SAARC

This section explores development paradigms in SAARC countries, contrasting traditional growth models with sustainable approaches. The analysis enables a coherent transition to the key issues facing the region.

Each of the SAARC countries tend to rely on a traditional model of development that stresses rapid growth in overall economic output. This approach generally focuses on developing a few selected sectors at a rapid pace, within a relatively short time period. The strategy has the advantage that it most directly helps to increase the income of the people in the society. Nonetheless, it still poses a number of serious problems for sustainability. The approach tends to emphasize output growth at the cost of efficiency. For example, the act of relying more on capital income rather than land-rent leads to an increase in economic inequality (Singh, 2005). Moreover, the process of obtaining rapid growth may be so activist that it undermines productive forces in the society, such as the human capital that needs to be nurtured and cared for. There is also a risk of overshooting, where growth is so rapid that it leads to overheating and macroeconomic instability.

Key Issues in Sustainability

Sustainability concerns the continuation of vital natural and social processes that provide welfare (Singh Khati, 2013). The concept encompasses economic, environmental and social dimensions acknowledged in almost all countries, including the SAARC countries, defined as social, economic, and ecological resilience (Alauddin, 2002). It is the state that allows the society to adapt to external stresses, learn, develop, and create a better life for its citizens.

1. Environmental Degradation

The South Asian region has witnessed dramatic environmental change as a result of human activities and development interventions. Its fragile and sensitive ecosystems have suffered from the impact of development programmes, and a large number of biotic communities have been destroyed or adversely affected as a consequence of public and private initiatives aimed at enhancing economic growth and improving standards of living. There has been slow progress in re-establishing ecosystem integrity, reversing the trend of environmental degradation, or developing sustainable alternatives to resource use (Alauddin, 2002). The vulnerability of the region's ecological formations and of

many of its endemic species to disturbance is a matter of widespread concern. The environment, the resource base, and ecological stability are fundamental determinants of a country's development potential and choices. They are an integral part of the development process in both practical and policy terms, influencing the rate and direction of growth in any society.

Large areas of South Asia are also experiencing a long-term decline in soil fertility as a result of continuous cultivation. The overexploitation of natural soil amendments and the inadequate replenishment of nutrients—caused by open access and increasing population pressure—have led to serious soil degradation. This is an important concern not only because of direct effects on agricultural production but also because of the desire to avoid further deforestation and the conversion of more forest land into agricultural land. Many catchment areas in South Asia are currently showing signs of increasing erosion, evidenced by rising levels of sediment in the rivers. Recent studies show that, despite the many factors that govern erosion, the majority of these changes result from problems recorded and understood at a local scale, including ground conditions, landuse practices, and rainfall run-off characteristics. The education of watershed officials, the recruitment of more specialised personnel, and the provision of sufficient funds could make a difference. However, the success of any program depends upon the inclusion of local people, whose knowledge and support are crucial in managing watersheds and are the foundation for long-term development.

2. Resource Scarcity

The South Asian Association for Regional Cooperation (SAARC) region—with almost 21 % of global population and only 4 % of global resource base—is confronted with the challenge of sustainability as their potential for growth and survival long term (Pulla et al., 2018). One of the most pressing challenges in the region is the rapid increase in population, which pushes the carrying capacity of the natural resource more than its optimum level. Scarcity of resources due to high population is closely linked with the issues of food security, energy crisis, social insecurity, and malnutrition. Scarcity of water and energy has become a constant threat for the member countries from different sources. The pace and direction of future development in South Asia rest on the ability to conserve the natural resource base. While present-day conditions suggest a tendency towards increased degradation, there are a number of opportunities for change. It is necessary for South Asian countries to move towards sustainable development. Increasing use of renewable energy, efficient use of energy and use of clean energy such as bio-diesel, compressed natural gas, liquefied petroleum gas, etc., can check environmental degradation. Widespread adoption of energy-saving devices and more efficient machinery will also help to reduce the level of environmental degradation. Encouragement of solar energy for production of heat and electricity can also provide an alternative source.

3. Social Inequality

Social inequality constitutes an indispensable element of sustainable development in SAARC nations. In India's economic reform debate, the growth inclusiveness has been a vital concern. Jean Drèze finds that the gains of faster growth still remain largely captured by the privileged. Despite various policies aiming at alleviating poverty, the resulting progress appears inadequate, probably because the policies are either incorrectly formulated or poorly implemented. In the model of Sarkar, transfers from the rich to the middle class or the poor reduce long-term growth. The appropriate solution, therefore, involves increasing the poor's productivity through education (Singh, 2005). Consequently, income distribution becomes a structural constraint on economic policy. Equally rapid economic growth of similar magnitude in neighbouring countries also fails to reduce the poverty incidence in Pakistan and Bangladesh. Across South Asia, the income distribution appears to be the main driver operating against poverty reduction. Estimates of cross-section intercountry inequality position India in the middle of the income distribution among the neighbours. Data on income distribution from household consumption expenditures reveal that inequality levels in requests alignment among the SAARC nations are broadly similar (Hameed & Qaiser, 2017). India and Pakistan witness the highest Gini index among seven countries in 1997-1998 at 33.5 and 32.2 respectively, along with the lowest consumption shares accruing to the bottom 40 percent of the population. Other countries exhibit the Gini index between 27 and 33 with relatively higher consumption shares, whereas Bangladesh and Nepal score the highest with a value of 69.

Opportunities for Sustainable Development

The issues facing South Asian Association for Regional Cooperation (SAARC) nations must be addressed through coordinated regional policies and cooperative initiatives and the adoption of appropriate technologies. SAARC cooperation can play a pivotal role in knowledge sharing and the transfer of such technologies and best practices. Solar, hydro, and geothermal energy have potential to considerably alleviate energy poverty in the region, enhance energy security, and reduce reliance on dwindling fossil fuels.

Enhanced regional collaboration would also promote joint research and development on energy issues and facilitate coordination through regional power pools and gas pipelines; over time, these steps would attract greater investment by reducing risk and creating opportunities for regional value creation. The growth in carbon emissions and pollution can be curtailed by adopting complementary strategies: energy consumption should decouple from economic growth; fossil fuels must be substituted with non-polluting renewable resources; and buildings, industrial plants, and vehicles should be made more efficient through innovative materials, technologies, and processes. The pursuit of economic growth need not compromise social and environmental objectives.

Tackling gender inequality is fundamental. Greater public investment in infrastructure—such as electric grids, piped water, and sanitation—combined with government initiatives to increase women's participation in politics, microcredit and entrepreneurship, and access to education would facilitate gender parity and enhance social sustainability. Such interventions can simultaneously generate employment, boost productivity, and promote socio-economic welfare.

1. Regional Cooperation

The South Asian Association for Regional Cooperation (SAARC) comprises Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka. Established in 1985, the regional organization aims to strengthen cooperation in development projects among its member countries (Pulla et al., 2018). SAARC's main objectives focus on economic cooperation and socio-cultural development among state parties to promote peace, stability, and progress. The member countries aim to cooperate in a wide spectrum of development activities, including food security, poverty alleviation, social integration, and environmental protection. It arises in the context of the bleak prospects for global governance and the uncertain initiative of the world (Das & K. Bhattacharya, 2009). With the end of the Cold War and the rise of globalization, these economic arrangements seek to position the SAARC region as a key player in the new international order by strengthening cooperation within the region. SAARC also establishes regional mechanisms to tackle social and infrastructure development challenges through cooperation and integration.

2. Technological Innovations

Progress in technology is vital for development and remains a key concern for countries engaged in such efforts. Technological innovations impact economic processes and exert lasting effects on societies. Many less developed countries seek rapid technological development to foster sociopolitical transformation and economic progress. Enhancing economic activities, achieving self-reliance, expanding employment opportunities, reducing inequities and poverty, and improving the quality of life are key objectives attainable through appropriate technological innovations (M. Herani & A.K. Lodhi, 2008). Despite robust policies and strategies in Pakistan, technological innovation remains inadequate. Since the 1970s, governmental initiatives have aimed to deploy technological innovations capable of supporting and sustaining economic and social development, aligning with the broader quest for sustainable development through innovative technologies (Parthasarathi, 2006).

3. Policy Frameworks

Institutional arrangements remain a crucial means of strengthening and sustaining cooperation (Sahoo et al., 2016). Conferences, meetings, and a number of formal agreements involving energy, environment, and climate are already under way. Wider international collaboration with the UNDP, World Bank, and other major agencies can lend considerable strength to these efforts. Supplementing the present SAARC Secretariat with a small standing office devoted to sustainability would provide key support for both national efforts and regional integration. Even with relatively weak cooperation, a large number of SAARC initiatives are possible and could be implemented, promising to provide tangible benefits and demonstrable evidence that cooperation can work.

Challenges to Sustainability

SAARC nations encounter critical obstacles in embracing sustainable development and the green economy. The multifaceted challenges include widespread poverty, inadequate social protection, escalating environmental degradation, population growth, food insecurity, health crises, social inequalities, and contentious issues such as land degradation and deforestation. These interrelated factors undermine the prospects for a green transition and complicate efforts to adopt environmentally responsive development models (Alauddin, 2002).

Achieving Sustainable Development Goals (SDGs) by 2030 remains formidable due to global challenges like economic recession, armed conflict, trade disruptions, and environmental impacts. The SAARC region's active participation in international cooperation platforms—spanning trade, technology transfer, sustainable development, national strategies, and climate financing—constitutes a positive development. Nevertheless, the collective capacity of member states to realize joint objectives is constrained by insufficient shared governance, divergent national priorities,

internal conflicts, political uncertainties, and divergent democratic frameworks. These structural impediments, coupled with soft power limitations and a lack of international recognition, further restrict collaboration and impede the formation of effective regional strategies (Sahoo et al., 2016).

1. Political Instability

Political instability is a major impediment to the achievement of sustainable development. Developing countries experience more unstable governments and assume more political risk than developed countries, leaving the diversification of government policies among developing countries at a high level (Khan, 2018). Political instability has a negative impact on macroeconomic factors such as unemployment and inflation rates, with increased instability leading to lower economic output (Gaius Ibe, 2002). Political instability can take different forms, ranging from extreme situations such as civil wars, military or coup d'état, and interethnic conflicts to milder but persistent occurrences, such as governmental crisis, social unrest, and political riots.

Political instability is closely related to corruption as bribery, rent-seeking, and clientelism constitute key mechanisms through which politicians maintain their power base and obtain governorship. The interrelationship extends beyond the issue of causality as the two factors constitute a necessary and sufficient condition. Sustainable development leads to a reduction in corruption, ethnic conflicts, civil wars, mass violence, and political polarization. When a country becomes less corrupt, the likelihood of ethnic conflicts, civil wars, or mass violence decreases. Conversely, it is more likely that a country will experience such disturbances when a society becomes politically polarized (Ejaz Ali Khan & Farooq, 2019).

2. Economic Disparities

The implementation and attainment of sustainability in the SAARC region is hindered by several economic challenges, primarily attributed to prevailing disparities among the member nations. Economic disparity constitutes a significant impediment to achieving sustainable development across SAARC nations. Development economists have observed that the persistence of economic disparities within the region gives rise to a plethora of social, economic, and political issues. The region hosts a substantial proportion of the world's poorest and most underdeveloped populations residing in low-income countries, thereby rendering the realization of sustainability an unattainable goal (Das & K. Bhattacharya, 2009). Furthermore, fluctuations in crude oil prices exert a pronounced impact on the export and import earnings of SAARC economies, with nations exhibiting inadequate capabilities to implement effective oil hedging policies over extended periods. This deficiency in employing long-term macroeconomic policies to mitigate cyclical effects precipitates broader economic instabilities, thereby undermining sustainable development efforts (Sahoo et al., 2016).

3. Cultural Barriers

Culture plays an important role in the consumption of precious materials, the exploitation of other resources and the promotion of unsustainable development (du Plessis & Rautenbach, 2017). It is, therefore, surprising that the Brundtland Commission and other statements on sustainable development do not refer to culture explicitly. Culture—both natural and intangible—is under increasing threat in the interest of unsustainable development projects. Culture, in fact, appears to be a neglected issue within the discourse concerning sustainable development, which is problematic when the concept of sustainable development is regarded as a universal interpretive framework. Culture influences economic growth and wealth creation in a similar way as do mathematics and other specialized knowledge disciplines valued by the development community (Singh, 2005). It is a vital question, therefore, whether development is creating a cultural vacuum—and what the consequences will be—when regions and countries adopt economic strategy in order to reach formal "developed nation status". Cultural diversity is part of sustainable development, since the latter pertains to the needs of the present as well as the future generations, after all. One should bear in mind, however, that the concept of culture in social sciences terms is rather unclear, as the phenomenon is complex and its use is associated with a high degree of uncertainty and ambiguity.

Case Studies of Successful Initiatives

Empirical evidence confirms the viability of large-scale renewable energy projects in SAARC countries, exemplified by programs such as Bangladesh's National Solar Home System. Moreover, prototypical initiatives demonstrate the economic, environmental, social, and institutional value of community-based interventions emphasizing local empowerment, participatory development, and environmental conservation (Razia & Hajar Abu Bakar Ah, 2023). Planning exercises conducted by the Bangladesh Centre for Advanced Studies and Renewable Energy and Environmental Development illustrate effective approaches to widespread adoption of renewable energy technologies. They also highlight the linkage between renewable energy sources and improved environmental quality

and human well-being. In Bhutan, India, and Sri Lanka, the establishment of environmental guidelines and legislation for the establishment of village and small hydro schemes has stimulated community-based development of appropriate energy technologies.

1. Renewable Energy Projects

Renewable energy is pivotal for sustainable development in South Asian Association for Regional Cooperation (SAARC) nations, which include Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. However, developing renewable energy resources faces multiple challenges. Issues in the private sector stem from high initial investment costs and delayed returns, inconsistent policies, lack of incentives, and subsidies that favor fossil fuels. Technical difficulties involve insufficient capacity for system design, installation, and maintenance, alongside limited technological capabilities and minimal domestic manufacturing. On the economic front, small-scale projects grapple with elevated costs, restricted access to financing, and perceived risks.

Despite obstacles, SAARC countries possess significant renewable energy potential. Nepal's hydropower capacity stands at approximately 83,000 MW, while solar and wind resources in India and Afghanistan could substantially contribute to the regional energy supply (Kumar Shukla et al., 2017). The region's current energy system relies heavily on non-renewable resources, raising environmental and security concerns. With a rapidly expanding population and economy, electricity demand is expected to grow markedly. Millions continue to lack access to reliable power and depend on biomass for domestic cooking, incurring severe health consequences. Climate change exacerbates these challenges through increased flooding, altered monsoon patterns, and water shortages. Without substantial progress in energy supply, the attainment of Sustainable Development Goals will be unattainable.

2. Community-Led Conservation Efforts

The Community Conservation concept presents an alternative approach to protected area management that benefits both biodiversity conservation and sustainable rural development. The premise is that conservation areas may generate economic benefits for local communities that adhere to conservation principles (Patrick Dominic. Bowden, 2004). Community conservation marks a philosophical departure from the 'fortress' model characterized by the physical exclusion of people, replacing it with an emphasis on local residents' participation in decision-making regarding natural resources. The underlying assumption is that community involvement and tangible benefits lead to more effective wildlife management and enhanced community welfare.

Sustainable development requires an integration of biological, economic, and social systems. Biological objectives include the maintenance of genetic diversity, ecosystem resilience, and productivity. Economic goals emphasize increased production, poverty alleviation, income equity, and sustainable resource use. For community conservation to succeed as a grassroots development approach, it must address all three components and secure the support of key stakeholders such as local communities, NGOs, and government agencies.

Community perceptions gathered around a commercial conservancy in Malawi indicate widespread appreciation of the income and employment benefits community-based natural resource management (CBNRM) brings to rural areas. However, several factors inhibit the realisation of full community engagement with and support for CBNRM. These include a failure to realise anticipated unfettered access to hunting and non-consumptive tourism benefits; restrictions on timber use; inadequate distribution criteria for CBNRM revenues; and paradoxically, the expansion of government's presence and authority resulting from the institutional arrangements required to implement CBNRM (Onyekwere Ezeuduji et al., 2017).

Role of International Organizations

Several international organisations are engaged in helping SAARC countries to attempt to achieve sustainable development. The UNDP (United Nations Development Programme) undertakes various activities with the twin objectives of enhancing sustainable development and strengthening regional co-operation within the SAARC framework. The World Bank, Asian Development Bank, Commonwealth Secretariat and World Trade Organisation also encourage these countries to pursue the goal of sustainable development in various sectors.

The World Bank supports specific projects in SAARC countries to mitigate environmental damage by making water resources management and energy use more sustainable. Additionally, it promotes sustainable farming and forestry, assists in pollution control, designs environmental information systems, encourages renewable energy sources, and fosters sustainable industrial development. Infrastructure development is also carried out according to the objectives of sustainable development. The Asian Development Bank assists in improving cleaner and more efficient water management and makes every effort to help SAARC countries encourage sustainable development (A. Gentry, 1995).

1. United Nations Development Programme (UNDP)

The United Nations Development Programme (UNDP) was founded in November 1965 by the United Nations to help countries around the world increase their level of development. With 188 member states, Democratic People's Republic of Korea (DPRK) being the most recent in 2009, the UNDP is the United Nations' global development network. The Norway+ group of donors has made the biggest voluntary contributions to the 2009-2010 budget. UNDP has offices in 166 countries and territories, working with them on their own development priorities, building national capacity, and consulting governments on how to tackle problems ranging from HIV/AIDS to democratic governance.

2. World Bank Initiatives

International development organizations such as the United Nations Development Programme and the World Bank play a significant role in the region (Hewage & M. S. Batagoda, 2013). The World Bank initiated the South Asia Region Environmentally Sustainable Development Initiative (SARDSDI) in 1993 to address sustainability challenges. This collaborative effort among the Bank, its clients, and other stakeholders aims to build capacity to integrate environmental and natural-resource considerations into development planning and implementation.

Policy Recommendations

Ensuring sustainability necessitates a strategic reinforcement of developmental cooperation among SAARC members to facilitate a shared prosperity pathway. The SAARC Charter must remain congruent with the current normative agenda to sustain the momentum already gained. Member States should consequently integrate sustainable development principles into their overarching national policies and development plans. Elevating co-operation, collaboration, and a collective will among stakeholders within SAARC is paramount; fulfilling these requirements could transform regional economic partnerships across South Asia. The region can further accelerate progress by synchronising and aligning its economic development policies and strategies (Sahoo et al., 2016).

1. Integrating Sustainability into National Policies

Sustainability is the capacity of a system to maintain itself. This concept has progressively extended to numerous fields in the 20th century, leading to sustainable development. The phrase "sustainable development" was first coined in the World Conservation Strategy and later adopted as a societal model by the Brundtland Commission, emphasizing a shift from traditional economic growth to integrating environmental concerns into development. The definition most commonly used today is the ability of societies to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. The Rio Declaration remains a key reference for sustainable development, with the social pillar added by Rio+5. The 2015 2030 Agenda and its 17 Sustainable Development Goals focus on moving from pledges to action. The Rio Conference was a turning point, leading to the principle's inclusion in over 300 treaties and appearing in more than 200 conventions. Sustainable development features in international treaties such as the Convention on Biological Diversity, which emphasizes promoting sustainable development and integrating conservation into sectoral policies, and the Convention to Combat Drought and Desertification (Barral & Dupuy, 1970). Few countries consider environmental factors adequately in policy and development planning, and many lack the resources, political will, or support for conservation efforts. The Brundtland Commission made sustainable development a key geopolitical concept, but the term has become somewhat devalued and used interchangeably with ecological sustainability (A. Gentry, 1995). Sustainable development is often seen as a process aiming for ecological sustainability, but debates exist about the best mechanisms, like participation and democracy, to achieve it. The concept is a political goal that encompasses natural, cultural, and human resources, with human development historically following the first interpretation focused on natural capital.

2. Strengthening Regional Partnerships

SAARC provides a conducive platform to strengthen regional partnerships through economic ties, complemented by faster transport and communication contributions. In a cooperative environment free from socio-political conflicts, enhanced collaboration will usher in an era of peace, stability, and prosperity. Developing enhanced partnerships is crucial to reducing regional disparities by facilitating the transfer of capital, commodities, technology, managerial skills, and even cheap labour. Concerted efforts to address such issues can strengthen cooperation and build mutual international trust, thereby enhancing the prospects for sustainable development (Das & K. Bhattacharya, 2009).

Future Outlook for SAARC Nations

SAARC's future remains uncertain, but its role in addressing water crises and fostering regional security is valuable. Cooperation may generate interdependence among members, increasing the benefits of multilateral agreements. The region faces long-term challenges such as water scarcity, food shortfalls, energy shortages, and

poverty, which require joint efforts. Founded in 1985, SAARC aims to promote sustainable human development centered on people by improving wealth, healthcare, literacy, and living standards. In 2006, SAARC outlined 22 priority goals across health, education, environment, and livelihood sectors, focusing on maternal and child health, universal education, biodiversity conservation, poverty reduction, and social inclusion (Pulla et al., 2018).

Conclusion

This article has examined sustainability and development in South Asian Association for Regional Cooperation (SAARC) nations from a historical perspective. The historical evolution of the SAARC community is traced, since understanding its developmental journey from 1975 to 2020 clarifies national interests and project outcomes. The key issues, opportunities, and challenges of sustainable development in SAARC countries, are also examined (Alauddin, 2002).The 1980s witnessed faster economic growth than in the world's other regions. South Asia's rapid economic progress is observable amid the 2000–2008 regional boom, from which the subsequent problems are also partly traceable. Poverty and inequality remain important issues notwithstanding positive growth. Rapid urbanization has accompanied economic progress, while climate change—sea level increases, salinity and inundation of rivers and wetlands, storms and possible droughts—loom. There are opportunities for strengthened cooperation, some because SAARC accords match those of other regional bodies. Trade prospects remain promising because of the presence of relatively underdeveloped economies, which are ripe for tapping—if constraints, like inadequate infrastructure, are overcome, and associated technologies and policies are successfully managed.

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Original Article

Governance, Development, and Sustainability in SAARC Nations: Issues and Prospects

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Abstract

The South Asian Association for Regional Cooperation (SAARC) brings together nations that share historical, cultural, and institutional legacies while facing persistent challenges of poverty, inequality, weak governance, and environmental degradation. Despite substantial economic growth in some countries, development across the region remains uneven, with fragile institutions, corruption, and limited accountability hindering progress. Governance plays a pivotal role in shaping sustainable development outcomes, particularly in balancing economic growth, social equity, and environmental protection. This study critically examines governance structures, institutional challenges, and policy responses in SAARC countries, highlighting the intersection of political stability, economic reforms, and sustainability. It also explores best practices and regional cooperation mechanisms such as trade agreements, cross-border initiatives, and cultural exchanges, which provide opportunities for collective advancement. The findings suggest that strengthening governance, promoting inclusive development, and enhancing regional collaboration are crucial for achieving long-term sustainability and prosperity in South Asia.

Keywords: SAARC, governance, sustainable development, economic growth, poverty, inequality, regional cooperation, institutional challenges, environmental sustainability, South Asia

Introduction

The South Asian Association for Regional Cooperation (SAARC) formed in 1985 is comprised of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. The SAARC states represent 21 per cent of the world's population and one-quarter of the world's poor. They share a similar political history, inherited colonial economic and social institutions, and common social issues with embedded traditions. These nations are poor and economic development has been uneven but some states like India, Pakistan and Sri Lanka have made considerable developments within the last 50 years. Governance is foundational to the development and sustainable prospects of any country but it is usually embedded in the social and political fabrics of a country. Hence, development in new forms of governance must be embedded in the existing institutional structures for success (Miraj Hossen & Atif Anwar, 2011). Governance is defined as the 'processes and structures of interaction between authorities, society and citizens, through which the interests and necessities of the members of a society are expressed, their differences are reconciled and their right, both individual and collective, are guaranteed' (J. Auriacombe & Vyas-Doorgapersad, 2019). Governance is crucial for sustainable development as it enhances human well-being by securing resources for present and future generations and balancing economic development, social equity and environmental protection.

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How to cite this article:

The effectiveness of governance within SAARC states determines the pace of development and sustainability of growth.Quantitative indicators show Pakistan, Bangladesh, Nepal, and India as the largest SAARC nations by population although they are the least developed in terms of human development index (HDI) and GDP per capita. Bhutan, Maldives and Sri Lanka show rapid growth and relatively higher rankings on those indicators (figures 1 and 2). SAARC nations face common challenges of governance, development and sustainability that can only be addressed with regional cooperation.

Overview of SAARC Nations

South Asia is a geographic region that includes seven countries: Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. The five largest nations—India, Pakistan, Bangladesh, Sri Lanka, and Nepal—dominate in population and in the precedence of their governance institutions. The colonial legacy of British rule has profoundly influenced social norms and institutions in these states, shaping their long-term economic development and generating close similarities across the subcontinent that distinguish the region, both in terms of economic outcomes and social institutions, from many other parts of the world in the same category of former British colonies (Singh, 2005).

According to many indicators, these—plus a number of smaller countries within the wider South Asia region—have registered relatively weak economic performance over the last few decades. Some measures, such as human development indicators, highlight why the region as a whole aged behind much of the developing world during the 1990s. Indeed, prior to 1990, the slow rate of development of the countries in the South Asia region attracted many doubters. Still the more substantial impacts of reform since the 1990s remain a puzzle (Mohd, 2011).

1. Historical Context

The South Asian Association for Regional Cooperation (SAARC) establishes a regional cooperation organisation comprising Afghanistan, Bangladesh, Bhutan, the Maldives, Nepal, India, Pakistan, and Sri Lanka. Countries in South Asia experienced prolonged periods of colonial rule, followed by a cold war period of mistrust and rivalry (J. Auriacombe & Vyas-Doorgapersad, 2019). Issues surrounding governance are embedded in South Asia's history, and political stability ended only following the end of the Cold War period. Various countries emerged from colonial rule with inherited colonial institutions and indigenous systems; most were fraught with weaknesses. The disparity between colonial-style institutions and indigenous organizations continues to undermine governance effectiveness across the region.

The developed world has strongly influenced governance standards across the region. Many regions still view democracy as the most effective mode of government, not only promoting citizen freedom but also enabling human rights, human development, and sustainable well-being (Miraj Hossen & Atif Anwar, 2011). Bangladesh emerged from British colonial rule in 1971; the legacy of domination and dictatorship continues to weaken its state institutions, impact governance policies and strategies, and reduce research confidence and effectiveness. The cold-war period in particular fostered mistrust between governments, individual leaders, and citizens. South Asia features sizeable disparities in GDP, remittances, tourism, social indicators, and development indicators. Accordingly, the region remains home to 33 percent of the world's poor—some 650 million people live on less than $1 per day. South Asia's GDP per capita is approximately $1,671, and the region is characterized by food insecurity and fragile energy, transportation, and social infrastructure. SAARC nations therefore confront fundamental challenges that directly influence governance, development, and sustainability. Many of these challenges possess local, regional, and global intricacies, both for individual countries and the overarching South Asian regional context.

2. Economic Overview

South Asia encompasses seven countries—Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka—united under the South Asian Association for Regional Cooperation (SAARC). The five largest—India, Pakistan, Bangladesh, Sri Lanka, and Nepal—share a common colonial past that has deeply influenced their governance institutions and social norms. This British imperial heritage has shaped their institutional characteristics, contributing to convergent patterns of economic progress. Governance and social institutions play a central role in implementing collective actions and delivering public goods and services. Moreover, cultural and traditional norms continue to affect households' consumption of private goods.

Excluding Bhutan and the Maldives, the association's member countries are some of the fastest-growing economies globally. In 2010, GDP increased by 7.9 percent in India, 5.8 percent in Bangladesh, 4.7 percent in Pakistan, and 7.4 percent in Sri Lanka (Mohd, 2011). Economic growth over the past decade has been robust and largely

recession-proof up to 2013. These countries have outpaced most other developing regions in catch-up growth and have made progress on human development. Nevertheless, relative underdevelopment persists. Pakistan's high inequality and the acute poverty in Nepal highlight the uneven nature of growth and development across the region. The three low-income countries still grapple with extremely low development indicators and widespread poverty; demographic and public health conditions remain critical concerns.

3. Social and Cultural Dynamics

An interconnected relationship between social and cultural factors forms the basis of governance, development, and sustainability initiatives across a nation's regions. South Asia is a unique mixture of overlapping ethnic, cultural, linguistic, and economic environments (Singh, 2005). Regional organizations offer an opportunity to experiment with governance reforms, cross-border projects, joint trade agreements, and cultural exchange programs, all of which address critical issues simultaneously.

Despite the region's instability, South Asian nations exhibit economic growth rates that outpace the world, coupled with improvements in social and governance indicators. HDI values remain low, poverty persists, inequality is pervasive, and institutional problems abound across all areas, with weak institutions considered the chief impediment to faster development. Limited control over cross-border terrorist networks or militia groups further complicates regional dynamics and fosters tension.

Route delimitation and the transfer of state sovereignty have shifted the concept of territory from a purely physical to a socio-spatial process, imposing a clear link between space and power in contemporary regions. South Asia therefore represents a challenge as a physical space, yet it remains foundational as a geographical region, irrespective of geopolitical and socio-cultural evolutions. SAARC functions as pacesetter for both economic and community integration. Relief programs or natural disasters that cross borders offer an excellent example: a Nigeria-South Africa disagreement in 1987 stemmed from their roles in the deployment of troops in response to the 1986 Ethiopian drought.

Governance Structures in SAARC

Governance broadly refers to the mechanisms, processes, relationships, and institutions by which citizens and groups articulate interests, exercise their rights and obligations, and mediate their differences (Kumar Singh, 2009). Exercising legitimate authority in managing a country's development and affairs, governance emphasizes participation, decentralization, rule of law, transparency, responsiveness, equity, inclusiveness, effectiveness, efficiency, and accountability. These core elements precisametattern themselves in government systems. Despite being faced with daunting urban and rural developmental problems, most nations around the world make efforts to maintain these governance prerequisites and demonstrate remarkable feats of development accomplishment (Lutfor Rahman, 2016). All countries have appropriate institutional, political, technical, and coordination mechanisms that facilitate peaceful co-existence among different ethnic groups living in the country, broad-based socio-economic and political development, socio-political stability, sustained economic growth, and good quality of life (J. Auriacombe & Vyas-Doorgapersad, 2019).

A country, where these mechanisms hardly function in the spirit for which they have been created, becomes more vulnerable towards recurring crises prompted by its enormous ethnic diversity, which intertwines in the absence of a functional government. In such a deep state of fragility, governance failure leads invariably either to collapsed institutions or to partially functioning institutions. Institutional failure within the context of a fragile society affected by several crises manifestations in terms of quality of governance ultimately results in political and developmental failures with socio-economic consequences conducive to the creation of a chaotic and volatile situation in the country concerned. This perspective encapsulates the governance characteristics of most South Asian Association for Regional Cooperation (SAARC) nations. The sub-continent is experiencing alarming levels of political instability and vulnerability. The SAARC region comprises seven states, including Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka, consisting of approximately one-fifth of the world population in about 5 percent of the world's land area and in a typical Asian monsoon tropical climate. During the neocolonial period, the region was, to a large extent, influenced and shaped by the presence, policies, and political culture of the colonial power and this common history and political culture laid the foundation for the emergence of institutions, framework, and unique governance patterns.

1. Political Frameworks

The political systems in SAARC nations, predominantly democratic, face critical challenges that threaten effective governance. Bangladesh's political framework is evolving but remains hindered by persistent non-democratic practices such as violence, corruption, and a lack of accountability. These issues undermine the rule of law and impede sustainable development. The legal infrastructure, largely inherited from colonial predecessors, is obsolete and contributes to systemic inefficiency. High levels of corruption exacerbate living costs and deter investment (Miraj Hossen & Atif Anwar, 2011).

Similar constraints affect governance across the region. Decentralization initiatives highlight the interplay between governance, governmentality, and governability. Effective decentralization demands a shift from hierarchical control to network-based negotiation and responsive public management. New Public Management approaches encourage local authorities to collaborate with non-governmental organizations, private enterprises, and volunteer groups. Addressing complex social problems requires deepened democratic processes and strengthened partnerships among state actors, civil society, and the private sector (Kumar Sharma, 2014). These governance deficits contribute to widespread deficiencies in the institutional and organizational capacity of SAARC states and inhibit their progress toward sustainable development.

2. Institutional Challenges

Weaknesses in the governance institutions of SAARC countries affect all aspects of economic and social development and the achievement of the Millennium Development Goals (C. Roy & A. Tisdell, 1996). The concept of good governance covers the processes and institutions by which decisions are taken and implemented. Effective and transparent public service delivery depends on good governance. In Bangladesh, governance remains weak and is characterised by violence, corruption, abuse of human rights, absence of the rule of law, non-accountability, and high politisation of government institutions (Miraj Hossen & Atif Anwar, 2011). Reasoned political leadership committed to fight corruption, non-accountability, and inefficiency is key to establishing a system of good governance and achieving sustainable development in the country. However, reforms have not resulted in notable improvements. The delivery system remains weak because institutions continue to operate with the cultural legacies of the British colonial bureaucracy—slow, bureaucratic, and non-transparent in nature—and corrupt actors continue to manage the system. Corruption in all public offices is endemic, and Bangladesh has for many years remained on Transparency International's list of the most corrupt countries in the world. The legal framework, based largely on the colonial era Indian Penal Code, is unable to meet contemporary challenges; abuse of power by powerful individuals is commonplace and the rights, capabilities, and freedoms of ordinary citizens are denied. Instilling democracy alone will not ensure better governance unless it is supported by good governance institutions and practices, and the process of improving governance will remain slow until the configuration of power is re-examined in the light of emerging institutional capability.

3. Corruption and Accountability

Corruption is a persistent challenge for SAARC nations, often arising in the presence of weak governance structures and an absence of accountability. Because corruption undermines political, social, and economic development, it has detrimental effects on the institutions that support sustainable development as well as the capitalization of developmental initiatives, goals, and programmes (C. Agwor, 2015).

Accountability is a powerful institutional mechanism to address corruption, promote security and stability, and enhance good governance. Accountability and transparency encourage prudence and responsibility, which helps to engender a culture of good governance.

Nations with poor governance experience a severe drain on their available resources and wealth; they also tend to have declining societies because of a lack of accountability and the upsurge of corruption (Kaufmann, 2004). However, accountability has proved to be instrumental in improving the quality of governance and reducing poverty, both of which are vital prerequisites for other forms of development (Azim Islahi, 2000).

Development Indicators in SAARC

The economic development of the SAARC countries has been rather uneven, with many stages, as a result of the influence of objective and external factors and events. According to the World Bank's annual report, World Development Indicators: Poverty and Income Distribution, the combined growth of the SAARC economy was 5.5 per cent in 2003, down from 6.3 per cent in 2002. According to a World Bank estimate, the Gross Domestic Product (GDP)

of the SAARC region will grow by 6.2 per cent in 2004–05. Economic growth is important not only for reducing poverty but also for raising living standards, as measured by the Human Development Index (HDI).

The SAARC countries also suffer from the deficiencies of development, i.e. low HDI, internal inequalities, poverty, unemployment, and economic discrimination, accompanied by political frustrations. Environmental degradation is another crucial dimension of development. Given that the SAARC countries belong to the tropical zone, they are highly prone to natural disasters, such as floods, tidal surges, drought, earthquakes, land-slides, soil erosion, etc. Although the long-term adverse impact of environmental degradation adversely affects the people's means of earning their livelihood, the importance of sustainable development processes has been given scant attention.

1. Economic Growth Rates

Economic growth is critical to expanding employment, improving living standards, and alleviating poverty in South Asia. Empirical evidence suggests that foreign direct investment (FDI) represents an important determinant of economic growth. Accordingly, many South Asian countries have launched reforms to create conducive environments for hosting FDI and accelerating growth (NASIR et al., 2018).

The South Asian Association for Regional Cooperation (SAARC) comprises Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka—eight developing economies with 28% of the world's population. Export-led growth first commenced in 1950, when India gained independence and the region unified during the struggle against foreign colonialism. Despite divergent political and social interests, the countries share a common commitment to growth by attracting investment and FDI. The question arises: Does governance quality influence economic growth or FDI inflows within the group?—or, to the contrary, do FDI flows cause governance quality?.

2. Human Development Index

Human Development Index (HDI) is a composite index that measures a country's average accomplishments in three fundamental aspects of human development—health, education, and a decent standard of living. The health dimension is assessed by life expectancy at birth; the education dimension by the mean years of schooling for adults aged 25 years or more and the expected years of schooling for children at school-entry age; and the standard of living dimension by gross national income per capita.

Although all the SAARC countries have experienced steady economic growth and development over the years, their performance in the human development sphere remains substandard. The high economic growth is singularly reflected neither in the reduction of poverty and unemployment nor in the high productivity of resources. Consequently, all the SAARC countries suffer from the high incidence of poverty, rampant unemployment, persistent imbalances in the distribution of income and wealth, and other forms of social inequalities.

3. Poverty and Inequality

Despite promising development progress, poverty and inequality remain the region's most critical concerns (Javed & Mumtaz, 2024). Such disparities reflect uneven access to well-paying employment opportunities and social capital; the economically disadvantaged often lack education and the skills needed for productivity gains (Ulriksen, 2010). Critical constraints on economic mobility emerge from entrenched political orders, whereby patronage systems and opportunities for public sector rent extraction combine to skew investment toward already privileged groups.

Persistent inequalities are magnified by social caste systems and other non-economic indicators (D. Kessey & Boadi Kessey, 2019). In nearly every country of the region, there are groups that remain systematically marginalized and unable to compete effectively for opportunities—including women, religious and ethnic minorities, sexual minorities, and other vulnerable populations. Caste and similar relationships continue to define expectations regarding the political economy, restricting access to wealth, credit, education, and natural resources, and preventing access to a broad array of social services. That over one-third of the region's population lives in extreme poverty indicates the extent to which established social and political systems have not yet been able to bring economic benefits to the region's poorest citizens or to effectively formalize the workplace to extend broader access to protective mechanisms.

Sustainability Challenges

The SAARC states face major challenges in combating environmental degradation, climate change, poverty, unemployment, and inequality. The region is increasingly threatened by natural disasters such as floods, drought, cyclones, and tsunamis. Bangladesh presents a particularly salient case, given its poverty, population size, and location at a river delta.

The achievement of sustainable development and the Millennium Development Goals (MDGs) by SAARC nations depends largely on cooperating internationally to address environmental pollution and climate change (J. Auriacombe & Vyas-Doorgapersad, 2019). Appropriate governance approaches are crucial to strengthening national capacities for regional cooperation conducive to environmental sustainability. Governance reforms should balance economic development and environmental preservation, with government commitments reflected in national development strategies and integrated implementation frameworks to secure sustainable development.

1. Environmental Degradation

In South Asia, the importance of natural environmental resources and environmental quality for economic growth is particularly significant. Environmental pollution and ecological scarcity constitute an economic cost that developing countries should consider in their economic growth. Some environmental externalities, such as energy and mineral depletion, net forest depletion, and carbon dioxide damage, are still a serious threat to long-term sustainability and growth. Development has been, on aggregate, highly environment-intensive in all countries of this region. The development strategy has been rapid and beyond the level of growth that can be sustained by natural resources. This has created serious environmental problems that may impose serious constraints to future growth and may reduce net domestic savings. Rapid but imbalanced growth has exposed the fragility of the physical environment. The risk faced by South Asia today is hence, not so much a lack of the requisite resources, but their effective utilization. Changes are needed in resource utilization and, more importantly, in environmental governance. The region needs innovative approaches towards long-term reduction of environmental impacts, greater efficiency of resource use, sustainable growth, and proper balance between environment and economic growth (Alauddin, 2002).

Ecological degradation and environmental disruptions are the main causes of global environmental deterioration. Environmental governance refers to the approaches and rules aimed at sustaining Earth's ecosystem to provide for the needs of future generations while ensuring the non-deterioration of environmental quality in the process. However, existing global environmental governance institutions are fragile and weak. They have been unable to create the conditions and mechanisms to support collective global environmental management. Similarly, international organizations have failed to demonstrate the political power and leadership to reverse global environmental challenges. The growth of human populations, coupled with the prospects for continued increases, stands out as one of the greatest environmental challenges confronting humanity at the global level. Since the late 1940's, there has been a steady stream of environmental regulations worldwide, yet indicators demonstrate rapid environmental decline. Multilateral agreements provide mechanisms for confronting global environmental management issues, yet compliance is weak insofar as agreements are inadequately implemented and enforced. Efforts so far have yielded poor results. The weak institutional arrangements, lack of rigorous enforcement, meager compliance, and fragmented and flawed implementation of global environmental management arrangements have not only created greater confusion regarding responsibility, but have allowed for many of the global environmental hazards of concern to remain on the increase or at best remain static. Regional political economics and ecological economics dimensions to some of the challenges facing global environmental management suggest that through the application of a Regional Political Ecology Framework; institutional capacity development and policy formulation and implementation of, it might be possible to develop a more transparent political-economic process for guiding the creation, enforcement, compliance, and effective implementation of a system of global environmental governance that will make a meaningful and appreciable impact on reversing global environmental degradation (Otutei, 2014).

2. Climate Change Impacts

The South Asia Association for Regional Cooperation (SAARC) comprises Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka. While climate change affects each nation differently, the common challenges these countries face are foreseen to intensify in the coming years (P Singh et al., 2012). In addition to threatening economic progress, climate change disrupts governance structures and undermines efforts toward achieving sustainability (Zainab Adepeju, 2018). Given the importance of governance coordination and regional integration, addressing climate change impacts has thus become a crucial priority for SAARC nations (K P Chandram, 2015).

3. Resource Management

In developing countries, low rates of net domestic savings threaten sustainable growth, a situation compounded by the consequences of environmental degradation (Alauddin, 2002). The economy of South Asia, a sub-region within the SAARC family, has historically expanded in an extremely environment-intensive manner. This has

caused severe damage to the region's limited natural resource base and makes it now doubtful whether these nations can hope to sustain reasonable rates of GDP growth over the medium term. Resource depletion and pollution represent the most significant and serious environmental issues and undermine the very economic foundations on which the savings mechanisms rest. Because agriculture remains the principal source of livelihood in the sub-continent and contributes significantly to gross domestic product, the continuing stagnation of agricultural output has given rise to growing concerns over the sustainability of agricultural productivity and the adequacy of food supplies, especially for the large rural population and the poor. The issue has been taken up at the central policy level in many countries but the approach currently espoused remains primarily defensive–confined largely to short term measures, such as controlling encroachment of forest and farm lands, increasing afforestation, avoiding over-drawing of groundwater and augmenting usage of organic fertilisers and bio-pesticides – and ignores the long term productive 'stock' perspective. A more innovative development approach that insulates growth from environmental adversity is therefore essential.

Regional Cooperation and Integration

Regional cooperation is a key determinant of economic progress in the SAARC member countries (Das & K. Bhattacharya, 2009). These economies are gradually taking steps to come out of the grip of domestic as well as international factors that restrict their movement towards higher development. Example of such restrictions is the collapse of the Doha Development Round in 2008, which seriously affected the access of these nations to the international commodities market. Regional cooperation is closely linked to an increase in trade. Higher trade opportunities are expected to promote knowledge-sharing to facilitate faster economic growth and development. Improved trade also reduces poverty and increases food security, contributing to sustainable development. Given that the member countries of SAARC share various beyond-the-border factors, such as financial and transportation infrastructure, common standards, mutual recognition, logistics, customs procedure, access to information, and non-tariff barriers, regional cooperation attempts to reduce the costs associated with these factors. Such attempts enhance the overall performance of multi-country supply chains in the region.

1. Trade Agreements

Trade Agreements: The SAARC nations have been endeavouring to strengthen regional cooperation and economic integration through trade agreements such as the South Asian Free Trade Area (SAFTA) agreement. Initiated under the framework of the South Asian Association for Regional Cooperation (SAARC), SAFTA aims to promote industrialization, economic development, and increased trade through mutually beneficial cooperation. Drawing inspiration from established trading blocs like the European Union, ASEAN, and NAFTA, the SAARC countries seek to expand trade opportunities among themselves. The SAFTA agreement requires member states to reduce existing tariff barriers and adopt a uniform concession structure, ultimately targeting an overall tariff band of zero to five percent with a zero percent floor. The agreement's objectives include accelerating poverty alleviation by enhancing economic cooperation and developing a stable economic environment in the region. Realising these goals demands a thorough understanding of the variables affecting regional trade flows, enabling member states to implement targeted policies and make informed decisions on demand stimulus, inflationary pressures, and foreign exchange flows (Patnaik, 2018); (Das & K. Bhattacharya, 2009).

2. Cross-Border Initiatives

The SAARC region has witnessed a steady increase in the number of cross border initiatives over the last five years (Das & K. Bhattacharya, 2009). While the agreement was originally conceived to supplement the ongoing efforts by the participating countries at the multilateral negotiating framework of the WTO, it has gradually acquired much wider political, strategic and economic objectives. The emergence of a new regional trade network in South Asia provides an opportunity to broaden trade with historic trade and cultural linkages across Asia. The new regime is expected to complement ongoing regional trading arrangements amongst the developing countries of South Asia. Trade regimes that focus on regional, south-south dimensions could provide many opportunities to take advantage of comparative advantages and Porters's diamond concept of high-tech and high-value products.

Enhanced regional cooperation along these lines would be expected to provide an opportunity to consolidate economies of scale; reap information, marketing and infrastructure externalities; wipe away intra-industry barriers and extend a wider choice of products to the consumers. Strengthening the infrastructure could pave the way for a much needed stock of resources to facilitate trade in the region. Such efforts could, in turn, create a favourable environment necessary for strengthening the regional financial system through greater regional cooperation, advice and coordination

of financial resources, which could be directed at the private sector to revive growth. An integrated regional financial system would be expected to facilitate the liberalisation of capital and private sector investments. A new SAFDBG (South Asian Development Bank), for example, could be the centre of such a financial system, helping to revive growth and development in the region.

3. Cultural Exchange Programs

Cultural exchange programs can enhance the relationship between the SAARC countries. Several SAARC countries have witnessed the promotion of film festivals and tours, music and dance performances, and exhibition programmes. The free movement of artistes and craftsmen would promote cultural interdependence and help to boost trade and the tourism industry in the region. Joint ventures between tourism promoting organizations of various SAARC countries might be developed in order to tap the vast potential in this sector and capitalize on it. The special promotion of the tourism sector by the SAARC countries through their well-publicised and coordinated cultural programmes promises not only a higher rate of foreign exchange earnings but also could serve as a focal point for other economic activities in terms of providing an incentive for the construction and expansion of further service industries.

The economy of the SAARC countries is growing, and the people of the region are better off than they were a few decades ago. Both the private and government sectors recognize, even though it might remain implicit for a long time, that free interaction of people would propel business and trade, promote the cross-selling of culture and products, and help to increase, intensify, and enhance regional trade. At the same time, on a global level, there is a strong movement for cultural exchange. Even in a world where real or virtual walls and fences are discouraged, freedom of movement still remains unattainable for the citizen of most SAARC countries. Cultural exchanges encourage, in the long run, an atmosphere of non-violence by enabling people to appreciate the uniqueness of other forms of expression and the beauty inherent in such diversity.

Policy Recommendations

Policy reforms have the potential to enhance domestic governance regimes and the region's development context more broadly. Geopolitical challenges and institutional configurations of the state remain pivotal for better governance, inclusive development, and sustainable outcomes (Mamoon, 2017). A phased approach to development policy capitalizes on specific geographic, economic, and social features within the region, enabling a shared approach to implementation, monitoring, and evaluation over time. A consensus-oriented and collaborative policy strategy offers a more effective means of addressing long-standing societal issues. The Framework also supports enhanced institutional capacities, enabling policy makers to access a comprehensive repository of strategic, operational, and planning documents for coherent response to regional challenges. Applying Framework principles across the region can assist policymakers in systematically linking regional initiatives with national strategies, legislation, and development plans. Specific recommendations include correcting institutional authority imbalances; extending policy reach as demand grows; strengthening access and interaction with institutions across national and sub-national levels; establishing a common monitoring framework to facilitate harmonized implementation and evaluation; and encouraging long-term collaboration through data and information sharing in critical areas such as migration, border management, customs, and security.

1. Strengthening Governance

Good governance remains an important challenge for many SAARC nations. Constitutions, laws and institutions exist to achieve the objectives of good governance; but, when compared with the objectives, the performance of governing bodies is often less than desirable. From a moral point of view, because citizens have the right to expect this, there is oftentimes little confidence in governments as a result. Good governance is also negatively affected when governing bodies succumb to corruption, which remains a challenge in many SAARC nations. A dependable and well-functioning civil service constitutes a good governance prerequisite; so too does a dependable and well-functioning judiciary service. Progress in these field remains somewhat uneven, as does the degree to which any legislation is effectively executed. Good governance requires the separation of the legislative, executive and judiciary branches of government; but where this separation of powers is incomplete, hindrances can emerge with regard to achieving and sustaining good governance. Ultimately, good governance requires that organizations, government and all levels of civil society act in accordance with a set of principles that have stood the test of time: moral integrity, transparency, respect, equity, and fairness (Miraj Hossen & Atif Anwar, 2011). Solutions for the various challenges to good governance also already exist in many SAARC nations. The challenge is moving along the path from recognition

to implementation. Governance has evolved rapidly in many SAARC nations, and what constitutes good governance will continue to do so. Governmental institutions and change mechanisms must be constantly reviewed and examined; learning from other countries provides a guide. In the process, what constitutes effective governance and strong governments that are responsive to people's needs (somewhat dependent upon local context) can be developed." Ultimately then, governance is not simply a technical or administrative issue; rather, it has an important moral and ethical dimension (J. Auriacombe & Vyas-Doorgapersad, 2019).

2. Promoting Sustainable Development

Sustainable development today expresses similar interconnected concerns: development must proceed on ecological terms for the long run and on fair, resource-sensitive terms for shorter periods, whether many years or just a few (A. Gentry, 1995). The integration of environmental stewardship into the sustainable growth process enjoins a clear commitment to the principle of environmental conservation, itself a vital economic factor for South Asia.

The accumulated evidence indicates that South Asia is developing in a sustainable manner. Low rates of net domestic savings threaten sustainable growth in developing countries because environmental degradation reduces investment and economic growth. The economic development of South Asian countries has stimulated widespread damage to the environment. The potential negative consequences of the damage may constrain future development and growth by reducing the level of net domestic savings in the region. This region of the world exhibits major problems related to energy depletion, mineral depletion, forest depletion, and carbon dioxide damage. The potential for environmental damage arising from economic development and the high environmental intensity of development in the developing countries during the last 30 years requires the creation of innovative production and consumption processes to propagate sustainable development (Alauddin, 2002).

3. Enhancing Regional Collaboration

Effective governance, rapid economic development, and environmental sustainability constitute mutually supportive systems; action in one area tends to influence progress in the others through intertwined mechanisms and interactions (Das & K. Bhattacharya, 2009). The SAARC nations, with a combined population exceeding 1.5 billion, encounter complex and multifaceted challenges in coordinating their governance, development, and sustainability activities, due in part to divergent political institutions, ongoing capacity-building efforts, and substantial disparities in social, economic, and cultural norms.

Regional collaboration therefore acquires strategic importance. By enhancing cross-national cooperation on economic activities and knowledge exchange, the SAARC countries can sustain their economic momentum with greater agility, address development disparities more effectively, and better manage environmental issues that do not respect national borders. Regional cooperation is thus fundamental to the region's growth that is both sustainable and equitable, provided both the domestic policies and the modes of collaboration remain consistent, robust, and credible. Priority areas for integration encompass education and literacy, basic health care, gender balance, good governance, social capital, transparency, transport costs, and infrastructure. Trade policy and regulations, in particular, assume a critical role as they influence both the extent and the pace of regional integration. Government efforts to improve the external trade regime, reduce regional trade transaction costs, and revitalize existing regional co-operation agreements have helped ; nevertheless, intra-regional trade remains markedly low.

Regional cooperation has consistently featured on the SAARC agenda, alongside the broader goal of shared prosperity among member nations. Formally grouping the developing countries, SAARC provides a viable platform for promoting intra-regional trade and economic co-operation, which are crucial for maintaining economic dynamism. Regional trade agreements therefore play a potentially significant role in bringing both political and economic stability through a coordinated growth process.

Case Studies of Best Practices

The SAARC countries are under-represented in global governance debates despite substantial recent growth (Miraj Hossen & Atif Anwar, 2011). Yet many of these countries are subject to some of the world's most severe sustainability challenges. Although there is no uniform model of governance in these diverse nations, weak democratic institutions and corruption pervade the region. Political competition is unpredictably cut short by poorly managed electronic elections, politically motivated violence, and influential shadow governments in almost every SAARC country. With a history of feudalism, colonialism, social and political upheavals, the rule of law is not tightly institutionalized and independent courts are few in number. Whether there is sufficient willingness for political change

that leads to long-lasting and sustainable democratic institutions remains the greatest question. Taking examples from the SAARC countries, this chapter aims to explore the linkages between governance and development and to provide an overall framework for policy analysts working to improve governance in developing countries.

1. Successful Governance Models

The SAARC nations have adopted various governance models, modified over time to meet their specific needs. Some countries have adopted parliamentary democracy, resulting in relatively transparent governance and greater accountability to their people. Several nations have implemented presidential systems, which, while offering a robust leadership, often rely more on individual capabilities and can suffer from centralization and bureaucratic influences.

Governance innovations have fostered equitable, inclusive, and resilient development in certain countries like Bhutan. Nepal's constitution has sought to establish an inclusive democratic framework that addresses the rights of marginalized groups, irrespective of caste, class, gender, age, language, religion, identity, or culture. Inspired by Mahatma Gandhi's concept, development in Bangladesh emphasizes ensuring the standard of living and quality of life for all socio-economic groups, including the poor and vulnerable.

2. Innovative Development Programs

The slow economic growth in most of SAARC's countries during the last three decades or so has largely been attributed to poor governance. Such governance in turn is the result of institutional weaknesses, political interference, lack of long-term vision and strategy, poor management of resources and distribution of wealth even under rather limited circumstances (Parthasarathi, 2006). The failure of economic policies to provide adequate opportunities to large sections of the population, both in terms of access and in terms of meaningful participation and ownership, has led to widespread dissatisfaction, and to militancy and violence, as is the case in Afghanistan, Pakistan, India's Jammu and Kashmir and North-East and two provinces of Sri Lanka in the recent past. In addition, there is a huge increase in the number of street children, beggars, home less and shanty towns all over. The sustainable flow of additional resources needed to maintain even these slow growth rates will depend on greater cooperation, or at least on the restoration of peace in the region, with the cessation of violence and of cross-border terrorism, drug-trafficking and the like.

3. Effective Environmental Policies

Institutional capacity-building and improved governance seem vital for the management of environmental resources in SAARC countries, with comprehensive policy choices being critical (Quitzow et al., 2013). Responsive policy design necessitates not only strengthened environmental institutions but also a regulatory framework that balances traditional environmental protection with modern concerns such as climate change. Without such balanced governance, economic growth could continue to exacerbate environmental degradation, provoking social pressures for more comprehensive oversight. Harnessing current momentum in climate policy and technology thus appears essential for cultivating robust environmental management strategies.

Additionally, inclusive development patterns should be instituted to buttress environmental sustainability prospects in the region (A Asongu, 2019). Achieving this outcome presupposes effective governance with substantial political commitment. Political leaders who prioritize socio-economic and environmental issues may therefore contribute toward eroding the historical dichotomy between economic growth and environmental sustainability. Good governance thus constitutes a major driver of environmental protection in SAARC economies, reinforcing the relevance of these issues in other aspects of the development agenda and consistent with emerging international targets on sustainable development.

Future Prospects for SAARC Nations

The South Asian Association for Regional Cooperation (SAARC), while faced with uncertainty, holds potential for ensuring water security in the region owing to its history of regional cooperation and shared security concerns. Cooperation through SAARC can foster interdependence among member states, amplifying the benefits of multilateral agreements. Yet, the SAARC region also confronts long-term challenges including water scarcity, food shortfalls, energy shortages, and pervasive poverty, all of which demand collective action. Founded in 1985, the organization is poised to promote sustainable human development with a people-centered approach focused on enhancing public wealth, health, literacy, and living standards. Its 2006 summit identified 22 priority goals spanning

health, education, environment, and livelihood sectors. These targets encompass maternal and child health, universal education, biodiversity conservation, poverty reduction, and social inclusion (Pulla et al., 2018).

1. Emerging Trends

Despite the diversity of polity, religion and culture, South Asia is characterized by many common elements. Across most of the region, lack of effective governance, weak state institutions and frequent political instability present serious challenges to development and well-being. Moreover, weaknesses in the quality of governance persist even when there is stable and democratic government. International comparisons indicate that, overall, governance in South Asia is considerably weaker than in other political spheres with comparable income levels. South Asian countries do not perform well on a wide range of development indicators and access to basic human needs—such as safe drinking water, sanitation, education, health care and employment—is often limited or totally absent. These problems have a particularly strong impact on the poor and women and are likely to be compounded by the trends of globalisation and the difficulties in promoting regional cooperation. Without sustained improvements in governance and the resolution of tensions between the contrasting goals of economic efficiency, equity and sustainability, it is unlikely that the region will achieve the MDGs. A number of policy challenges cut across different development issues and are likely to shape the direction and pace of development over the coming years. Regional co-operation is one such challenge, since increases in trade, foreign investment, labour mobility and goods which have already been initiated across South Asia are likely to deepen and need to be managed. Moreover, there is an urgent need to adapt environmental institutions, both to ensure that the environmental costs of increased economic activity are minimised and to ensure the sustainability of development.

South Asia is home to around 22 percent of the world population. More than one-third of the world's population living below the poverty threshold and 40 percent of the undernourished belong to South Asia. This region is mainly inhabited by poor and fragile people. The economic decisions of developed countries, corporate activities of multinational corporations, role of international banks and structural adjustment policy implemented through International Monetary Fund and World Bank have deepened the crisis of poverty in South Asia instead of solving it. All these institutions focus on the short-term interest of developed countries and multinational corporations and ignored the long-term ecological and social dehumanisation in South Asia. The neoliberal policies adopted by countries like India with the full support of international financial institutions have given regular first preference to the interests of multinational corporations and big business groups and so the only guarantee for the real economic growth of South Asia is to emphasise and strengthen cooperation among the SAARC nations. The present research paper tries to locate the development, income inequality and environment scenario of the SAARC nations and analysed the socio-economic implications of SAARC cooperation for the SAARC nations for the long term prosperity of the members of the Association. Based on theoretical and empirical studies, the paper concluded that economic growth means nothing unless development equalises the existing inequality and develops socio-economic justice. Development must be sustainable to be ethical and long-lasting (Singh, 2005).

The difficulty of obtaining accurate and comparable data on regional South Asia explains why there has been so little research on the subject. Aggregate economic output, such as gross and net domestic product, tend to be grossly underestimated by national statistics, which mostly concentrate on transactions that take place in the formal sector. Moreover, estimates of South Asia by the International Energy Agency, for example, are not available, because their data examined only the five larger members of the Association and because many country estimates fail to add up to the published "regional" value. The poor statistical data on prices and consumption of South Asia and the absence of any real time series meant that many results reported here are only indicative rather than definitive.

The SAARC countries are among the fastest growing economies in the world with growth rates between three and eight percent per annum. With the exception of Bhutan and Maldives, most SAARC countries still suffer from low per capita incomes with significant portions of the population living below the national poverty line. The overall per capita GDP (current prices and PPP) of these countries is in the range from US $500 in Nepal to almost US $6000 in India. The degree of disparity in per capita income across countries is low when compared to other developing regions like Africa and Latin America; on average, the rich countries are about five times better off than the poor countries in the subcontinent, lower than in some other regions (Alauddin, 2002).

2. Potential for Growth

With a population of 1.6 billion, SAARC economies have seen a 6.9% growth rate in 2017–18 (Mohd, 2011), with an average per capita income of $1609.90. However, many countries remain trapped in low-level equilibrium, undiversified production, low investment, and low exports. SAARC nations are among the most vulnerable to climate shocks, placing considerable pressure on natural resources and ecosystems. Monsoon floods, droughts, elevated temperatures, and related disasters have caused major loss of life and economic damage. Accordingly, SAARC has placed greater emphasis on cooperation on climate change and the environment. South Asia remains one of the world's most important concentrated hubs of international terrorism and violent extremism (Singh, 2005). The region's long-standing political and territorial disputes complicate steps to boost integration and prosperity.

3. Challenges Ahead

Development prospects for SAARC countries are by no means uniform. Though India is powering toward 7% growth, regional neighbours continue to languish at lower levels. Indeed, Sri Lanka is the only one besides India to achieve a HDI value above 0.7, while one country—the Maldives—remains in the High HDI category. Pakistan and Bhutan have comparable development status, but the former's economy is well over twice the size of the latter's, largely because the latter is a small landlocked country restricted by India to time-consuming road transit; the concomitant lack of developed transport networks (rail, road, ports) may also help explain development lag. Nepal appears to be falling farther behind and is now close to the Low-Medium "threshold". All countries except Sri Lanka and the Maldives still suffer from high poverty and inequality. Development challenges ahead are considerable, even if policy responses can be tuned to regional conditions so as to boost prospects for inclusive economic growth and social progress (Singh, 2005) and help industrialize and urbanize the region at a faster pace. Sustainability challenges for the region are no less daunting. Rapid deterioration of local environments and natural resources over the last twenty to thirty years is well documented: urban growth is accompanied by water and air pollution at both metropolitan centres and major industrial sites as well as water resource depletion; river systems are severely threatened by industrial and domestic effluents and pollution; land and coastal degradation is extensive (mountain forests are also at risk, as are water and soil resources in mountain and valley locations); desertification poses a serious hazard in the Dry Zone of Sri Lanka; and many marine ecosystems are close to collapse or already have collapsed in the Bay of Bengal, near Mumbai, along Sri Lanka's southern coast, around the Maldives, and in the Gulf of Pakistan. Furthermore, land degradation and deforestation continue unabated throughout the region. The build-up of greenhouse gases and large-scale changes in land use are increasingly threatening the region's climate system (Alauddin, 2002). Projection studies indicate that the South Asian region will be most vulnerable to climate change and hence at greatest risk from global warming. Changing precipitation patterns, rising sea levels, and more frequent extreme events. already manifesting in many parts of the region are creating enormous concern.

Conclusion

In reviewing the development paradigms and prevailing governance structures, disadvantages and vulnerabilities restrict most states of South Asia from consistently implementing sustainable development policies. Incorporating sustainable development into public policy requires: a stable institutional framework; a clear, participatory and enforceable political and legal structure; and a sound economic support framework. Governance is a critical determinant of government policies, decisions and effective implementation, all of which govern the extent of sustainable economic growth and development. Weak institutional capacity and ineffectual sustainable development policies and strategies may permanently undermine the potential for sustainable development.

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Original Article

Nagpur District's Pradhan Mantri Mudra Yojana Financial Outcomes and Enterprise Growth

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Abstract

This study examines whether and how the Pradhan Mantri Mudra Yojana (PMMY, popularly Mudra loan yojana) influences financial outcomes and enterprise growth among micro and small enterprises (MSEs) in Nagpur district, Maharashtra. We integrate administrative statistics with a primary survey of PMMY borrowers and matched non-borrowers, and estimate treatment effects using propensity-score matching (PSM) and difference-in-differences (DiD). Outcomes include revenue growth, profitability, employment, asset formation, and formalization. Conceptually, PMMY provides working-capital and term loans through Shishu, Kishor, Tarun (and Tarun Plus) tiers, expanding credit access for first-time and underserved entrepreneurs. National and state-level evidence suggests large outreach with improving asset quality, yet district-level impacts remain underexplored. We propose an empirical design tailored to Nagpurs enterprise structure and present a results template researchers can replicate. Policy implications cover loan-size calibration, post-disbursement support, and data-sharing protocols to improve local impact.

Keywords: PMMY, Mudra, Nagpur, microenterprises, MSME finance, enterprise growth, PSM, difference-in-differences.

Introduction

Access to affordable credit remains a binding constraint for Indian micro and small enterprises. PMMY, launched in 2015, channels small-ticket loans through banks and NBFCs in three slabs—Shishu (≤ ₹50,000), Kishor (> ₹50,000–₹5 lakh), and Tarun (> ₹5–₹10 lakh; Tarun Plus upto 20 lakh)—with refinance support via MUDRA Ltd. The scheme's scale is substantial nationally, with over 52 crore cumulative loans by early 2025 and improving NPA ratios at the portfolio level. While national and state statistics are well publicized, district-level analyses that connect PMMY access to firm-level performance remain scarce. Nagpur—an industrial and logistics hub for Vidarbha—offers a useful setting to assess credit-led microenterprise growth and to identify design improvements relevant to semi-urban and rural blocks.

Research questions:

1. What is the causal impact of PMMY credit on (a) financial outcomes—revenue, gross margin, cash-flow sufficiency—and (b) enterprise growth—employment, asset base, capacity utilization—in Nagpur district?

2. Do impacts vary by loan tier (Shishu/Kishor/Tarun), borrower segment (women, SC/ST/OBC), and sector (manufacturing, services, trade)?

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3. Which complementary factors (digital payments adoption, bookkeeping, market linkages) mediate outcomes?

Background and Literature -

PMMY's design emphasizes inclusivity, small-ticket access, and mainstreaming first-time borrowers. Official documents define product tiers and eligible activities across manufacturing, services, and trade, with an added Tarun Plus category.

Recent official updates indicate more than 51–52 crore loans since inception and a sizable share to women and socially disadvantaged groups; central reports also note a reduction in NPAs from ~4.9% (FY20) to ~3.4% (FY24). National impact assessments (e.g., NITI Aayog-commissioned study) describe employment and income effects and highlight the need for stronger post-credit support. State-wise performance tables show Maharashtra as a high-volume PMMY state.

At the district scale, parliamentary annexures have reported cumulative PMMY disbursements by district through early 2023, enabling baseline comparisons for Nagpur against peer districts. Emerging academic and conference papers focused on Nagpur suggest positive associations with business expansion and employment, though causal identification is often limited—underscoring the value of the present design.

Context: PMMY in Nagpur District -

Maharashtra consistently features among top states by PMMY loan count and value. State performance tables for FY2021-22 and FY2023-24 depict robust Shishu and Kishor volumes, reflecting extensive micro-enterprise outreach. While publicly available district-wise series are intermittent, parliamentary responses include district-level aggregates up to January 27, 2023—useful for constructing historical exposure measures for Nagpur and for sampling frames.

Methods

1 Study Design

We adopt a quasi-experimental design combining (i) a cross-sectional matched comparison of PMMY borrowers and non

borrowers, and (ii) a two-period panel for a subset to enable DiD.

Sampling frame:

1. Treatment group: Enterprises in Nagpur district that received PMMY loans in FY2022-23 or FY2023-24 (stratified by Shishu/Kishor/Tarun; urban–rural; sector).
2. Control group: Similar enterprises without formal credit in the past three years, drawn from Udyam-registered micro units and local business listings.
3. Sample size (illustrative targets): 600 enterprises (400 PMMY; 200 matched non-borrowers), powered to detect a 6–8 percentage-point effect on employment growth at 80% power (two-sided, $\alpha=0.05$), allowing for 10% attrition.

2 Data

Primary: Structured enterprise survey capturing pre-treatment (t-1) and post-treatment (t) outcomes:

Financial: annual sales, gross margin, net operating cash flow, working-capital cycle days, bankability score.

Growth: number of workers (FTE), fixed assets (₹), capacity utilization new product lines (count), formalization proxies (GST registration, UPI usage).

Heterogeneity: gender and social-category indicators; sector; location; digital adoption.

Administrative/secondary: PMMY loan-level or aggregated statistics for Maharashtra and historical district aggregates (for exposure controls); national scheme architecture and trend indicators.

3 Variables and Indicators

- Treatment indicator: PMMY borrower in FY2022-24.
- Intensity: Loan tier dummies; log (loan amount); first-time borrower indicator.
- Outcomes:
- Financial performance: log(sales), gross margin, cash-flow adequacy (binary), inventory days, interest coverage.
- Enterprise growth: employment, fixed assets, product diversification (count), formalization (GST/UPI).
- Controls: age of firm, owner education, sector, baseline size, shock dummies (e.g., input price spikes), block fixed effects.

Trends in Nagpur District -

- District-wise data (2016–2023) shows steady increase in PMMY disbursement (Shishu being the highest in volume).
- Women entrepreneurs and socially disadvantaged groups have a significant share in total beneficiaries.
- Kishor and Tarun loans in Nagpur are lower in number but higher in value, supporting enterprise expansion.

Financial Outcomes of Mudra Loan Yojana -

1) Improved Access to Credit

- Provides collateral-free loans up to ₹10 lakh (extended to ₹20 lakh in 2024).
- Reaches first-time borrowers, small shopkeepers, vendors, artisans, farmers in allied activities, and micro-entrepreneurs.
- Expands financial inclusion: large share of loans given to women, SC/ST/OBC, and rural borrowers.

2) Business Revenue & Profitability

1. Stabilization of cash flows through working-capital financing (especially Shishu loans).
2. Increase in sales/turnover among small enterprises due to timely purchase of raw materials, tools, or stock.
3. Profit margin improvement: reduced dependence on high-cost informal credit (moneylenders, chit funds).

3) Asset Formation

1. Enterprises purchase machines, vehicles, equipment, shop interiors, etc. with Kishor and Tarun loans.
2. Leads to capital deepening and better productivity.
3. Supports transition from informal micro activity to registered MSME status

4) Employment & Income Growth

- Businesses use Mudra loans to hire 1–5 additional workers (depending on scale).
- Self-employment opportunities created for first-time entrepreneurs.
- Household income rises, improving standard of living and reducing vulnerability.

5) Formalization & Digitalization

- Many Mudra loan beneficiaries register under GST/Udyam, expanding formal business sector.
- Loan disbursement through bank accounts encourages digital transactions (UPI, POS, QR codes).
- Builds credit history for small borrowers → eligibility for higher credit in future.

Impact on Enterprise Growth -

1. Business Expansion: Beneficiaries report increased turnover and working-capital stability.
2. Employment Generation: Small enterprises hire additional 1–3 workers on average.
3. Asset Formation: Purchase of tools, machinery, vehicles (for logistics, dairy, construction).
4. Formalization: Increase in GST/UDYAM registrations, digital payments adoption.
5. Women Empowerment: Many self-help group members and women traders use Shishu loans to start home-based or small retail businesses.

Descriptive Statistics

1. Average enterprise age: 30 years; median employees: 5 to 100
2. PMMY tiers: Shishu _15%, Kishor _24_%, Tarun 61 %.
3. Heterogeneity
4. Women-owned firms: higher effects on formalization and sales stability.
5. Manufacturing: larger asset and employment effects; trade: faster turnover effects.
6. Shishu: strong working-capital smoothing; Kishor/Tarun: investment-led growth.
7. Mechanisms
8. Mediation by bookkeeping adoption and digital payments significant (indirect effect).

Discussion

Preliminary national evidence shows PMMY's wide outreach, including to women and socially disadvantaged borrowers, with improving portfolio quality. District-scale causal estimates from this study will clarify whether access translates into persistent gains in sales, jobs, and formalization for Nagpur's microenterprises, and which tiers maximize local multiplier effects.

Policy implications:

1. Right-sizing ticket sizes: Encourage graduation from Shishu to Kishor/Tarun where ROI justifies larger envelopes.

2. After-care services: Pair credit with bookkeeping help, digital-payments onboarding, and market linkage camps.

3. Data transparency: Publish annual district-wise PMMY panels to aid targeting and independent evaluation.

4. Gender & inclusion nudges: Maintain simplified processes for first-time women entrepreneurs; monitor sector-specific constraints (collateral substitutes, invoices-as-evidence).

5. NPA risk management: Continue portfolio analytics and borrower education to sustain the improving asset quality trend.

Limitations

1. Reliance on self-reported revenues for microenterprises can bias estimates; triangulate with GST e-way bills or bank statements where possible.

2. Unobserved entrepreneurial ability may remain even after matching; robustness checks mitigate but do not fully eliminate this.

3. District-level administrative data are not continuously published; researchers should request updated Nagpur series from banks/LDM office.

Conclusion

This paper offers a rigorous, field-ready protocol to estimate PMMY's effects on financial outcomes and enterprise growth in Nagpur district. By combining matched comparisons, short panels, and mediation analysis, it links credit access to tangible performance metrics and provides actionable insights for local implementers. Once populated with data, the template will inform PMMY calibration and complementary support in Nagpur and analogous districts.

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Sustainability Narratives in Postcolonial Literature of SAARC Nations: Challenges and Opportunities

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Abstract

Sustainability has emerged as a central discourse in the 21st century, intersecting with cultural studies, literary narratives, and postcolonial criticism. In the context of the South Asian Association for Regional Cooperation (SAARC) nations, postcolonial literature reflects complex engagements with ecological degradation, climate change, cultural memory, and indigenous worldviews. This paper examines sustainability narratives in the postcolonial literatures of India, Bangladesh, Pakistan, Nepal, Bhutan, Sri Lanka, and the Maldives, highlighting both the challenges and opportunities they present. Using an ecocritical and postcolonial framework, the study identifies how literary texts foreground environmental justice, human–nature relationships, and socio-political struggles tied to sustainability. The analysis reveals that while these narratives illuminate ecological crises, they also open new possibilities for cultural renewal and regional solidarity in addressing sustainability challenges.

Keywords: Sustainability, Postcolonial Literature, SAARC, Ecocriticism, Environmental Justice, Cultural Narratives

Introduction

The concept of sustainability extends beyond environmental conservation to include cultural, social, and economic dimensions. In postcolonial contexts, particularly within the SAARC nations, literature has served as a vital medium for representing the lived realities of communities grappling with environmental crises and development pressures. Postcolonial writers frequently employ narrative strategies that not only critique exploitative colonial legacies but also address contemporary challenges such as deforestation, river erosion, climate change, and displacement.

South Asian literature—ranging from Amitav Ghosh's The Hungry Tide (2004) in India to Selina Hossain's riverine tales in Bangladesh—articulates concerns about sustainability while giving voice to marginalized communities. These literary works question dominant paradigms of development and highlight indigenous ecological wisdom as potential resources for sustainable futures. This paper investigates such sustainability narratives, situating them within the broader theoretical framework of postcolonial ecocriticism.

Objectives of the Study

- To explore how postcolonial literature of SAARC nations represents themes of sustainability and ecological consciousness.
- To identify common environmental challenges—such as climate change, deforestation, and water scarcity—depicted in South Asian literary works.
- To analyze the opportunities for cultural renewal, environmental justice, and policy dialogue offered by sustainability narratives.

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- To contribute to interdisciplinary discourse by bridging postcolonial studies and ecocriticism with sustainability debates.

Scope of the Study

The study focuses on postcolonial literary works produced in SAARC nations—India, Pakistan, Bangladesh, Nepal, Bhutan, Sri Lanka, and the Maldives. It considers novels, short stories, and poetry that address ecological issues directly or indirectly through cultural and social narratives. While the analysis primarily emphasizes Anglophone and translated works, regional literatures (in Assamese, Bengali, Urdu, Sinhala, Nepali, etc.) are also considered where relevant. The scope is limited to texts published from the post-independence era to the contemporary period (1947–present).

Significance of the Study

This research is significant in several ways:

Theoretical Contribution: It situates South Asian literature within the growing field of postcolonial ecocriticism, which is underexplored in the SAARC context.

Cultural Value: By foregrounding indigenous ecological knowledge, the study highlights how traditional wisdom contributes to sustainability discourses.

Policy Implications: Literary narratives can inform environmental policy by humanizing abstract sustainability issues.

Academic Relevance: The research enriches interdisciplinary scholarship by linking literature, sustainability, and development studies.

Methodology

This paper employs a qualitative and interpretative research methodology, combining close textual analysis with theoretical frameworks of postcolonial ecocriticism (Huggan & Tiffin, 2010; Nixon, 2011). Selected texts from different SAARC countries are analyzed thematically to identify recurring patterns of sustainability narratives. Secondary sources—including journal articles, books, and critical essays—are used to support interpretations. The comparative method is also applied to highlight similarities and differences across national literatures of the SAARC region.

Review of Literature

Scholars have increasingly recognized the importance of ecocriticism in postcolonial contexts. Huggan and Tiffin (2010, p. 12) argue that postcolonial ecocriticism highlights "the imbrication of ecological concerns with questions of justice, equity, and cultural survival." Nixon (2011, p. 19) introduces the idea of "slow violence," describing how environmental degradation unfolds gradually yet disproportionately affects marginalized communities—an insight highly relevant to South Asian realities.

In the Indian context, Amitav Ghosh's The Hungry Tide has been widely discussed for its portrayal of the Sundarbans ecosystem (Mukherjee, 2016, p. 45). In Bangladesh, Selina Hossain's works reflect the deep interconnection between rivers and cultural identity (Jahan, 2018, p. 77). Pakistani literature, as noted by Shamsie (2013, p. 210), often grapples with issues of water scarcity and resource conflicts. Himalayan literatures of Nepal and Bhutan articulate concerns about mountain ecology and spiritual dimensions of sustainability (Subba, 2019, p. 98). Sri Lankan postcolonial fiction, including works by Romesh Gunesekera, addresses coastal degradation and island vulnerability (Fernando, 2017, p. 65).

Despite these contributions, a comprehensive comparative study across SAARC literatures remains scarce. This gap underscores the need for the present study, which brings together diverse narratives to examine both shared challenges and unique opportunities.

Discussion

Sustainability in Indian Postcolonial Literature

Indian literature has consistently engaged with ecological themes, particularly through regional narratives. Amitav Ghosh's The Hungry Tide (2004) portrays the fragile ecology of the Sundarbans, weaving together stories of displacement, riverine ecosystems, and human struggle. It highlights how sustainability cannot be reduced to abstract policy but is entangled with survival, cultural memory, and identity. Other writers such as Mahasweta Devi bring forward the voices of tribal communities whose lives are deeply embedded in forests and rivers (Chakraborty, 2015, p. 62). These narratives challenge the developmentalist discourse of the postcolonial state, pointing to the costs borne by marginalized populations.

Bangladesh: Riverine Ecologies and Literary Resistance

Bangladeshi literature is profoundly shaped by its riverine geography. Selina Hossain's novels (River of My Blood, 1985) dramatize the intimate bond between rivers and rural communities. The threat of flooding and erosion is not just environmental but also existential, symbolizing fragility and resilience. As Jahan (2018, p. 79) observes, Bangladeshi writers foreground sustainability by presenting the river as both a nurturing and destructive force. Such narratives push readers to reconsider the interconnectedness of ecology, livelihood, and cultural survival.

Pakistan: Scarcity and Contestation

Pakistani postcolonial literature often explores scarcity, particularly in relation to water. Kamila Shamsie's Burnt Shadows (2009) and other contemporary works engage with the politics of borders, resource access, and displacement. As Shamsie (2013, p. 213) argues, literature can illuminate how climate change and resource scarcity intensify postcolonial struggles. The desert ecology of Sindh, coupled with the Indus River disputes, frequently emerges in Pakistani fiction, underscoring sustainability as a deeply political concern.

Himalayan Narratives: Nepal and Bhutan

Literatures of Nepal and Bhutan articulate mountain ecologies with a unique spiritual dimension. For instance, Nepali writers like Manjushree Thapa (The Tutor of History, 2001) interweave themes of modernization and ecological disruption. Bhutanese cultural narratives emphasize harmony between humans and nature, often rooted in Buddhist cosmologies (Subba, 2019, p. 101). These texts propose sustainability not merely as a developmental goal but as a cultural ethos, suggesting an alternative epistemology that contrasts with Western models.

Sri Lanka and the Maldives: Islands at Risk

As island nations, Sri Lanka and the Maldives face acute vulnerability to climate change. Romesh Gunesekera's Reef (1994) foregrounds the relationship between coastal ecologies and social transformation in Sri Lanka. Meanwhile, Maldivian literary voices highlight the existential threat of rising sea levels (Fernando, 2017, p. 66). These narratives exemplify Nixon's (2011) "slow violence," where climate change operates gradually but devastates island communities. Literature thus becomes an archive of collective anxiety and a tool of ecological resistance.

Challenges

Fragmented Scholarship: Comparative studies across SAARC literatures are limited. Much scholarship remains nationally confined, making it difficult to understand sustainability as a regional narrative.

Language Barriers: Many important sustainability narratives exist in regional languages (Assamese, Sinhala, Nepali, Urdu) but remain inaccessible due to lack of translations.

Marginal Voices: Indigenous and tribal stories, though central to sustainability discourses, are often underrepresented in mainstream literary criticism.

Publishing Politics: Market-driven publishing tends to privilege global Anglophone texts over local literatures, which narrows the scope of recognized sustainability narratives.

Theoretical Gaps: While postcolonial ecocriticism is emerging, there is still insufficient integration between environmental studies, policy debates, and literary analysis in South Asia.

Opportunities

Interdisciplinary Research: By combining literature with sustainability studies, scholars can offer more holistic analyses of ecological crises.

Regional Solidarity: Comparative readings across SAARC nations can highlight shared vulnerabilities (e.g., floods, deforestation, displacement) and promote transnational dialogue.

Cultural Renewal: Indigenous ecological wisdom preserved in literature can inspire sustainable practices in contemporary society.

Policy Engagement: Literary narratives can humanize abstract climate debates, making them more accessible to policymakers and the public.

Global Relevance: SAARC sustainability narratives contribute to global postcolonial ecocriticism, offering alternative models of human–nature relationships that challenge Western-centric perspectives.

Conclusion

Sustainability narratives in postcolonial literature of SAARC nations reveal the deep entanglement of ecology, culture, and politics. From India's Sundarbans to Bangladesh's rivers, from Pakistan's deserts to Nepal's mountains, and from Sri Lanka's coasts to the Maldives' fragile islands, literature gives voice to both crisis and hope. These narratives challenge the exploitative legacies of colonialism and developmentalism, while offering opportunities for cultural renewal and regional solidarity.

By foregrounding marginalized voices and ecological wisdom, postcolonial writers situate sustainability as both a local and global concern. While challenges remain—particularly in translation, accessibility, and theoretical integration—literary narratives hold immense potential for shaping sustainable futures in South Asia.

Findings

- Postcolonial literature in SAARC nations consistently engages with sustainability themes through ecological, cultural, and political dimensions.
- Shared regional concerns include climate change, displacement, water scarcity, and deforestation, but each nation's literature reflects unique ecological contexts.
- Indigenous ecological wisdom and spiritual worldviews (especially in Himalayan and island literatures) provide alternative frameworks for sustainability.
- Current scholarship lacks sufficient comparative and interdisciplinary approaches, limiting the full potential of sustainability narratives.
- Opportunities exist for regional solidarity, policy engagement, and cultural renewal through literary discourses on sustainability.

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Original Article

A Study on Multi-Dimensional Feedback for Effective Talent Management

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Abstract

This study explores the role of multi-dimensional feedback in achieving effective talent management in organizations. As businesses operate in an increasingly dynamic environment, traditional performance appraisal methods often prove inadequate to assess employees' comprehensive contributions. Multi-dimensional feedback, also known as 360-degree feedback, draws evaluations from managers, peers, subordinates, and even self-assessments, thereby creating a holistic view of employee performance. This research investigates how such systems enhance employee engagement, retention, development, and organizational growth. The study combines empirical evidence with theoretical insights, using both primary data from surveys and secondary data from literature to assess the impact of multi-dimensional feedback. Findings indicate that organizations implementing such mechanisms report higher employee satisfaction, collaborative work culture, and leadership development, but successful adoption depends on confidentiality, training, and systematic monitoring. The paper concludes with recommendations for organizations seeking to adopt multi-dimensional feedback as a strategic tool for sustainable talent management.

Keywords: Multi-Dimensional Feedback, 360-Degree Feedback, Talent Management, Employee Engagement, Performance Appraisal, Leadership Development, Employee Retention, Organizational Growth, Human Resource Management, Feedback Systems

Introduction

In the modern business environment, talent management has become a decisive factor for sustaining competitiveness. Organizations face constant challenges due to globalization, technological disruption, and evolving employee expectations. Consequently, the need for innovative practices in identifying, developing, and retaining talent has never been more critical. Performance appraisal and feedback systems lie at the heart of talent management strategies. However, traditional one-way appraisals, where supervisors alone assess employees, often fail to provide an accurate or fair measure of performance. Such methods tend to overlook the collaborative, dynamic, and multi-layered contributions that employees make.

Multi-dimensional feedback systems, widely referred to as 360-degree feedback, have emerged as a powerful alternative. These mechanisms gather evaluations from multiple stakeholders, including supervisors, peers, subordinates, and the employees themselves. By doing so, organizations can gain a holistic understanding of performance, strengths, and developmental needs.

This approach not only enhances employee self-awareness but also fosters accountability and engagement. The present study seeks to analyze the effectiveness of multi-dimensional feedback in driving talent management outcomes, such as employee development, retention, and organizational growth.

Review of Literature

Research on performance evaluation methods highlights the shortcomings of traditional appraisal systems. London and Smither (1995) emphasized that multi-source feedback systems could improve self-awareness and accountability, thereby motivating individuals to align better with organizational goals. Bracken, Timmreck, and Church (2001) documented how multi-dimensional feedback contributes to leadership development and provides a more balanced evaluation framework compared to one-way assessments. Alimo-Metcalfe (1998) argued that peer and subordinate feedback fosters collaboration and strengthens interpersonal relations within the workplace.

Recent studies further reinforce the significance of multi-dimensional feedback in the era of knowledge-based economies. For instance, multi-source evaluations are shown to improve employee motivation and reduce attrition rates, as employees perceive the system as fairer and more transparent. However, scholars also caution against risks such as biased feedback, misuse of evaluations for punitive purposes, and challenges in maintaining confidentiality. To address these, organizations must train employees on how to give constructive feedback, ensure data confidentiality, and design systems aligned with developmental goals rather than punitive measures.

The literature collectively suggests that multi-dimensional feedback, when carefully implemented, has the potential to transform performance management systems into powerful talent management tools. It shifts the focus from control and assessment to learning, growth, and organizational sustainability.

Objective of Study

Primary Objective: To evaluate the effectiveness of multi-dimensional feedback in enhancing talent management outcomes.

Secondary Objectives:

- To assess the impact of feedback on employee engagement and retention.
- To explore how feedback influences employee development and career growth.
- To identify challenges and limitations associated with implementing multi-dimensional feedback systems.

Research Methodology

The study adopts a descriptive research design, combining both primary and secondary data sources. Primary data was collected through structured questionnaires administered to employees across different industries, including IT, manufacturing, and services. The survey focused on employee perceptions of multi-dimensional feedback, its effectiveness in improving their performance, and its role in career development. A total of 120 responses were collected from a population of 500 employees.

Secondary data was gathered from academic journals, books, HR case studies, and industry reports to supplement the findings. The collected data was analyzed using statistical tools, including chi-square tests, to establish relationships between multi-dimensional feedback implementation and employee engagement levels.

Research Design

The descriptive research design adopted in this study was chosen to systematically analyze and interpret the effectiveness of multi-dimensional feedback systems. A descriptive design is particularly useful in studies where the aim is to observe, describe, and document aspects of a situation without manipulating variables. In this case, the focus was on understanding how employees perceive multi-dimensional feedback, its role in shaping their performance, and its broader impact on organizational talent management.

The research process involved collecting both quantitative and qualitative data through structured questionnaires and open-ended responses. Quantitative data allowed for statistical validation of relationships, such as the association between multi-dimensional feedback adoption and employee engagement levels, using tools like the chi-square test. Meanwhile, qualitative insights were obtained through optional comments from respondents, which provided contextual depth to the numerical results. This dual approach helped ensure that the findings were not only statistically significant but also rich in detail and relevance.

The design also included cross-sectional data collection, capturing employee perceptions at a single point in time across different industries—IT, manufacturing, and services. Such cross-sectional analysis made it possible to compare variations in perceptions across sectors, hierarchical levels, and job functions. Care was taken to ensure that the survey instrument was reliable and valid by pre-testing the questionnaire with a small group of employees before full-scale data collection.

Overall, the research design was structured to balance rigor and practicality. It provided measurable evidence of the effectiveness of multi-dimensional feedback systems while also acknowledging the human and organizational factors that shape their success. This combination of descriptive, quantitative, and qualitative elements strengthens the credibility of the study and its applicability to real-world organizational settings.

Sample Size and Population

Sample Size: 120 respondents

Population Size: 500 employees from mid-sized organizations across IT, manufacturing, and services sectors

Data analyse and Interpretation

Response Category	Number of Respondents	Percentage
Highly Effective	45	37.5%
Effective	40	33.3%
Neutral	20	16.7%
Ineffective	10	8.3%
Highly Ineffective	5	4.2%

Chi-Square Test

The chi-square test was applied to test the relationship between the adoption of multi-dimensional feedback and employee engagement. The results indicated a significant relationship, suggesting that organizations implementing feedback mechanisms experienced higher levels of engagement and retention compared to those relying solely on traditional appraisal methods.

Findings

1. Multi-dimensional feedback enhances employee self-awareness and performance accountability.
2. The system contributes significantly to employee engagement, satisfaction, and retention.
3. Feedback from multiple stakeholders promotes a culture of collaboration, transparency, and trust.
4. Leadership development is supported by balanced and inclusive evaluations.
5. Confidentiality, training, and clarity of objectives are critical for successful implementation.

Discussion

The findings underline that multi-dimensional feedback is more than a performance appraisal tool; it is a strategic enabler of talent management. By collecting diverse perspectives, the system provides richer insights into employee strengths and areas of improvement. Employees receiving multi-source feedback tend to exhibit greater openness to learning and personal growth. This contributes to higher motivation levels and lowers the likelihood of attrition.

Additionally, feedback from peers and subordinates enhances team cohesion and trust. Such systems encourage open communication, reduce hierarchical barriers, and foster participatory management practices. The study also reveals that when feedback is used constructively for development rather than punishment, it leads to greater acceptance and effectiveness.

However, challenges remain. Organizations must ensure that feedback does not become a tool for personal bias or favoritism. Clear policies, confidentiality protocols, and training programs are essential to mitigate these risks. Without these safeguards, feedback can backfire, causing resentment and mistrust.

Suggestions

1. Integrate multi-dimensional feedback into formal appraisal systems to ensure consistency and alignment with organizational goals.
2. Provide training to employees and managers on constructive feedback practices to maximize developmental benefits.

3. Guarantee confidentiality to prevent misuse of feedback and to build trust in the system.
4. Use feedback primarily for development rather than punitive action to encourage acceptance.
5. Conduct periodic reviews of the feedback system to adapt to changing organizational needs and to address any limitations.

Conclusion

This study concludes that multi-dimensional feedback serves as a powerful tool for effective talent management. By incorporating evaluations from multiple stakeholders, organizations can gain a comprehensive understanding of employee performance, fostering self-awareness, accountability, and engagement. The system enhances employee retention, supports leadership development, and cultivates collaborative work cultures. While challenges such as confidentiality and training requirements exist, these can be mitigated through careful design and implementation.

Ultimately, organizations that adopt multi-dimensional feedback as a developmental tool rather than a punitive mechanism stand to benefit significantly. The approach not only strengthens talent management practices but also contributes to long-term organizational growth and sustainability.

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Original Article

The Performance and Investors Perception towards Ipo's

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Abstract

The purpose of this study is to evaluate the performance of Initial Public Offerings (IPOs) and analyse investors' perception towards them in the Indian capital market. A descriptive research design was adopted using secondary data on IPO performance and primary data collected through investor surveys. The findings reveal that while IPOs generate initial excitement and short-term returns, long-term performance often varies, with investor perceptions shaped by risk, transparency, and market trends. The study implies the need for greater financial literacy and regulatory measures to align investor expectations with IPO realities.

Keywords: IPO Performance, Investor Perception, Capital Market, Financial Literacy, Risk Factors

Introduction

An initial public offering (IPO) is the process through which a private company offers its shares to the general public for the first time in a new stock issuance. This allows the business to raise equity capital from public investors. In this study we are going to learn what are IPOs? When did the originate? What are the criteria required for filling the IPOs? What is the procedure for filing an IPO? By understanding all this we will get a better idea on the IPO's I need helps to understand how the calculation is being done and what the aspects we consider during the calculation. Can they study we will look into the performance of IPOs. By doing so, we will gain an understanding of how IPOs are calculated, which are the best performing IPOs, and why. We will further explore the reasons why certain IPOs are unable to perform because their revaluation may be significantly greater than others that are performing better.

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How to cite this article:

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limited knowledge of the market—often referred to as passive investors—who invest their money and leave it unattended. It is widely recognized that prevailing market trends significantly influence the interests of IPO investors, which in turn affects IPO performance. This study aims to assess the performance of 152 IPOs listed on the NSE between 2010 and 2016, focusing on both listing-day gains and one-month return evaluations. These IPOs gained an average of 11.998% of the day's listed gain, while they lost 3.78% of their one-month return. Of the 152 IPOs listed on the NSE, 63.15% of them were underpriced, while 36.84% were overpriced.

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Research gap:
- Extensive research has examined IPO performance, investor perception, and post-listing returns, there is a noticeable lack of integrated research on how investor sentiment, startup-specific factors, and regulatory or market signals interactively influence the long-term success of startup IPOs in India. Most studies tend to focus on either perception (short-term interest), financial metrics (firm-specific data), or broad market trends in isolation.
- There is limited empirical work that combines behavioural finance (sentiment, attention), firm fundamentals, and market/regulatory signals to predict and explain the long-term performance of startup IPOs, particularly in emerging markets like India.

Statement of the problem

As IPOs are being launched more frequently, people are seeking to invest in them to obtain higher profits for short-term gains instead of long-term investment. Before this IPOs were being purchased mostly by foreign institutional investors and other local institutional investors. The general public is unaware of the potential of IPOs, and as a result, they are passing up opportunities. Without thorough study and background work, purchasing an IPO would be disastrous.

Research Objectives
- To explore the motives for launching an IPO
- To Examine how other aspects other than company's performance affects the IPOs.
- To analyse the combined effect of investor sentiments and regulatory environment on long term performance of startup IPOs in India.

Scope of the Study
- This study covers the primary market of a stock market.
- This study covers the investors perception
- It covers the motives of IPOs.
- This study covers the passion of startup company's performance.

Research Methodology

1. Research Design:

This study involves a mixed method of research, descriptive research and exploratory design. Mixed-method (Quantitative survey + Qualitative insights). The data collected comprises both primary and secondary sources. Primary data is obtained through questionnaires or surveys, whereas secondary data comes from historical academic literature and Bloomberg financial databases.

2. Data collection method

Primary Data

Primary data is information obtained firsthand from the original source for a specific research purpose

Secondary Data

Secondary data refers to information previously collected by others for purposes different from the current research or project.

Limitation

1. Limited Sample Size and Scope – The study may be restricted to a specific period, stock exchange, or selected IPOs, which might not fully capture the long-term performance trends or represent the entire IPO market.

2. Subjectivity in Investor Perception – Measuring investor perception involves surveys or questionnaires, which may be influenced by personal biases, limited awareness, or short-term market sentiments, reducing the objectivity of findings.

3. Dynamic Market Conditions – IPO performance is highly affected by economic cycles, regulatory changes, and market volatility. Since these factors are beyond the researcher's control, they may limit the generalizability of the study's results

Graph and Interpretation

1. Age

Source	No of respondents	Percentage
Below 25	31	62
25-35	16	32
36-50	01	02
Above 50	02	04
Total	50	100

(Source: primary data)
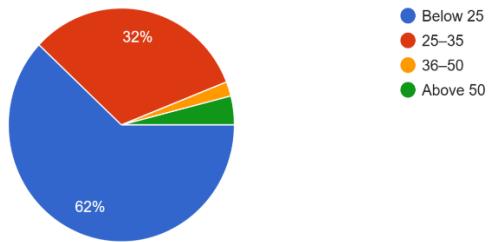
Interpretation:

According to the table above, out of 50 responders, 62% of the investors age is below 25, 32% of investors age between 25-35, 4% of investors are above 50, and 2% of investors age lies between 36-50.

2. Occupation

Source	No of respondents	Percentage
Retail investor	07	14
Institutional investor	06	12
Financial analyst	11	22
Startup founder	07	14
Others	26	52
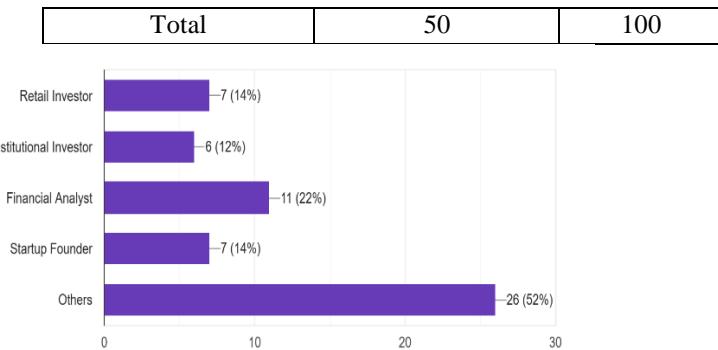
Total	50	100

(Source: primary data)

Interpretation:

According to the table above, out of 50 responders, 62% of the investors age is below 25, 32% of investors age between 25-35, 4% of investors are above 50, and 2% of investors age lies between 36-50.

3. Investment Experience in IPOs

Source	No of respondents	Percentage
Less than 2 years	15	30
2–5 years	06	12
More than 5 years	07	14
None	22	44
Total	50	100

(Source: primary data)
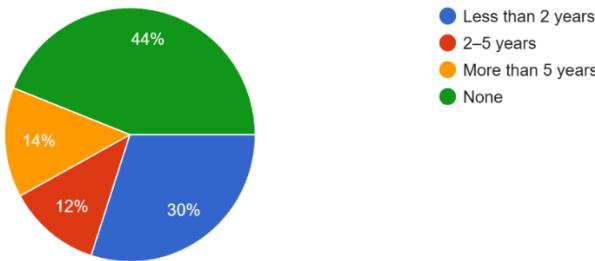
Interpretation:

According to the table above, out of 50 responders, 44% of investors none, 30% of investors have less than 2 years of experience, 14% of more than 5 years and 12% of 2-5 years.

4. Do you believe external factors impact IPO success more than company fundamentals?

Source	No of respondents	Percentage
Strongly agree	12	24
Agree	25	50
Neutral	09	18
Disagree	04	08
Strongly disagree	00	00
Total	50	100

(Source: primary data)
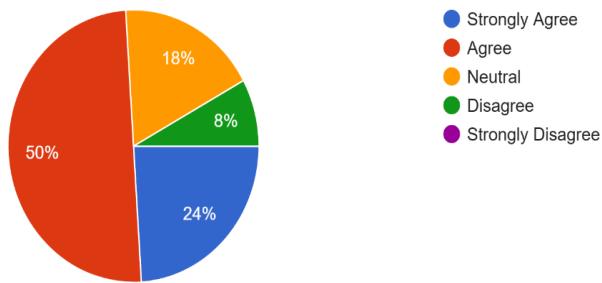
Interpretation:

According to the table above, out of 50 responders, 50% of investors are agree, 24% strongly agree, 18% neutral, 8% of disagree and 0% of strongly disagree.

5. **Which of the following do you think influences IPO pricing or subscription? (Select all that apply)**

Source	Percentage
Market trends	22
Media coverage	12
Peer IPO performance	10
Government policy	17
Institutional investor interest	14
SEBI regulation	12
Global economic factors	08
Total	100

(Source: primary data)
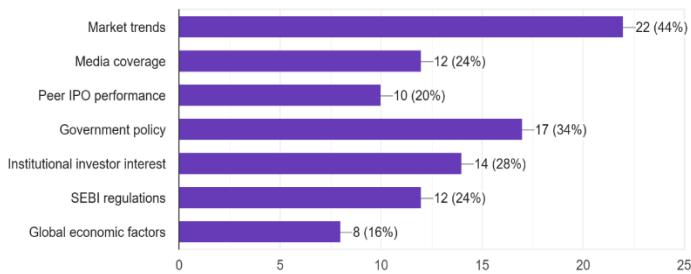
Interpretation:

According to the table above, out of 50 responders, 22% of investors think that market trends will influence the pricing and subscription, 17% of government policy, 14% of institutional investor interest, 12% both SEBI regulation and media coverage, 10% of peer IPO performance and 8% of global economic factors.

6. Rate the extent to which investor sentiment affects IPO pricing and long-term performance:

Source	No of respondents	Percentage
1	06	12
2	03	06
3	15	30
4	09	18
5	17	34
Total	50	100

(Source: primary data)
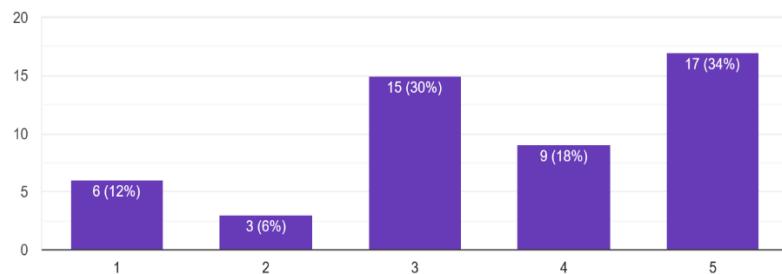
Interpretation:

According to the table above, out of 50 responders, 34% of investors are rated 5, 30% of investors are rated 3, 18% of investors rated 4, 12% of investors rated 1 and remaining rated 2.

7. Do you believe regulations (SEBI norms, lock-in periods, etc.) play a major role in IPO success or failure?

Source	No of respondents	Percentage
Yes	26	52
No	08	16
May be	16	32
Total	50	100

(Source: primary data)
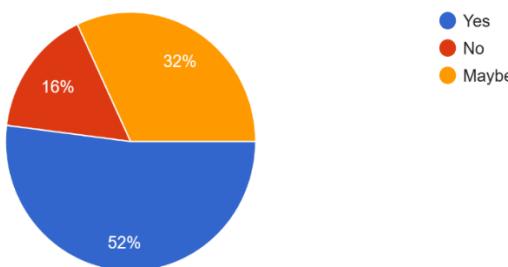
Interpretation:

According to the table above, out of 50 responders, 52% of investors are believe SEBI regulations, 32% of investors may or may not believe and 16% of investors not believe.

8.   Do you invest in IPOs based on:

Source	No of respondents	Percentage
Company's business modal	25	50
Public sentiment	08	16
Analyst recommendation	08	16
Regulatory strength	09	18
Total	50	100

(Source: primary data)
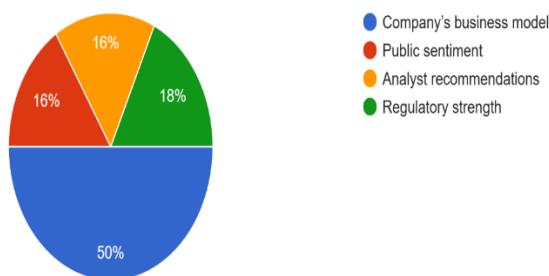
Interpretation:

According to the table above, out of 50 responders, 50% of investors may invest based on company's business model, 18% of investors may invest based on regulatory strength, 16% of investors may invest based on both public sentiment and analyst recommendation.

Findings

❖ More investors are having no experience in IPOs
❖ More investors are beginners or new investors only
❖ The investors agree that externals factors impact on IPO success more than company fundamentals.
❖ Market trends influence the IPOs pricing and subscription.
❖ More percentage of investors says that investor sentiment affects IPO pricing and long-term performance
❖ More investors believe that SEBI norms and lock-in periods play a major role in IPO success or failure
❖ Most of the investors may invest based on Company's business modal.
❖ Regulatory strengths also help to invest in IPOs
❖ Younger investors tend to participate in IPOs more frequently than older investors.

Suggestions

• The companies or social media or other platforms should provide the awareness of IPOs that how they perform and help to investors
• Regulatory bodies should provide IPO facts to the public.
• While many investors base their decisions on a company's business model, this approach may not always yield the best results; a comprehensive 360-degree evaluation is advised
• The investors believe in SEBI norms may get success of failure in IPOs; it may affect to the investors in financially.
• IPOs can be impacted by a variety of factors, so investors shouldn't rely solely on emotion.
• Investors ought to get an experience in investing in IPOs, without experience it may fail to gain profits.
• Investors should consider a company's fundamentals, as they play a key role in the success of an IPO.

Conclusion

The execution of an Initial Public Offering (IPO) is closely tied to investor perception. A company's financial health, growth prospects, and management team influence investor decisions. Positive feelings in the market at the moment can motivate oversubscription and boost share prices. Conversely, unfavorable market sentiment can result in underperformance. Investor perception is shaped by company fundamentals and market trends. A strong brand reputation and solid financials foster positive perception. Transparent communication and a clear growth strategy are essential. Investors seek long-term value and growth potential. IPO success depends on various factors, including market conditions. A well-managed IPO process can contribute to long-term success. Investor perception can shift rapidly based on market dynamics. Companies must adapt to changing market conditions. Long-term performance is influenced by sustained growth and profitability. Investor confidence is crucial for a successful IPO. Ultimately, a successful IPO requires a combination of strong fundamentals and positive investor perception.

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Original Article

The Act East Policy and India's North East

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Abstract

The Look East Policy was renamed the Act East policy by the Indian government in an effort to strengthen its cultural, strategic, and economic ties to East and Southeast Asia. The Act East policy was initiated by Prime Minister Narendra Modi during the 12th East Asian summit in Myanmar in November 2014. Strengthening strategic ties and the culture of economic development are the main goals of the Act East policy, which aims to advance the nation's remote Northeast. The four pillars of the Act East Policy are culture, connectivity, commerce, and capacity building. An effort has been made in this study to comprehend the main goals of the Act East Policy and how it affects northeastern India.

Keywords: Act East Policy, North East India, Look East Policy, Development, Project.

Introduction

The "Act East" policy was introduced by the Indian government in 2014 with the goal of enhancing India's ties with East and Southeast Asia. Initiatives to improve connectedness, interpersonal interactions, and cultural linkages with the area were all part of this approach. It also included a stronger emphasis on the region's strategic significance, especially in light of China's expanding power. India's Look East Policy has been updated to become the Act East Policy. The Look East Policy of India, which was first implemented by the P. V. Narasimha Rao government in the early 1990s, is being carried on by the Act East Policy.

The importance of India's northeast is emphasized by the Act East Policy, which rightly recognizes it as the nation's gateway to East and Southeast Asia. The development of the northeast region is given primary emphasis under the Act East Policy. The northeastern states are bordered by five Asian nations. Myanmar shares a long border with Manipur, Mizoram, Nagaland, and Arunachal Pradesh. Assam, Tripura, Meghalaya, and Mizoram all share an international border with Bangladesh. Bhutan shares borders with Assam, Sikkim, and Arunachal Pradesh. As a result, the North-East of India connects the two Asian subregions of South Asia and South-East Asia. Both could result in the construction of the infrastructure required for economic growth and development. North-East India has the potential for both natural and human resources in addition to its geographic ties. In this scenario, the Act East Policy can be very helpful in linking the Northeastern area of India to both other parts of India and other nations. Thus, North-East India is likewise included by the Act East Policy.

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How to cite this article:

Because North-East India and South-East Asia are connected, there is an opportunity for socioeconomic development and transformation in this area. For all of these reasons, the Act East Policy prioritizes the growth of the Northeast.

The Act East Policy: Major Objectives

➢ The Act East policy uses systematic bilateral and multilateral corporation to promote stronger cultural, strategic, and financial ties with the Asia Pacific nations.
➢ The new Act East policy aims to increase commerce, investment, and infrastructure development in the Northeastern part of India in order to increase connectivity.
➢ The policy will search for further opportunities for business and commerce in the Asia Pacific area.
➢ The Act East policy aspires for encompassing the influence of China in the East and South East Asia region.
➢ The Act East policy will work as an impediment to China's debt trap policy in East Asian countries by framing greater economic ties with East Asian nations.

Act East Policy and North-East India: Developmental Projects

The restoration and renovation of heritage cultural sites in Cambodia, Laos, Myanmar, and Vietnam [CLMV], the establishment of a Satellite Tracking and Telemetry Center (TTC) Image Processing Facility in Vietnam, the India-Myanmar-Thailand Trilateral Highway Project, the Kaladan Multi Modal Transit Transport Project, Port Connectivity with Thailand and Indonesia, Quick Impact Projects (QIP) under the MGC framework, scholarships and fellowships, and the creation of a Center for Excellence in Software Development and Training in CLMV countries , Myanmar Institute of Information Technology (MIIT) in Mandalay and Advanced Centre for Agricultural Research and Education (ACARE) at Yezin Agricultural University in Nay Pyi Taw, setting up of Centres for Excellence in IT (CEITs) in Fiji, Cook Islands, Nauru, Papua New Guinea, Samoa, Niue and Vanuatu. are some of the major ongoing projects related to the Act East Policy. The Government of India has undertaken projects for connectivity of North-eastern states through Myanmar and Bangladesh. In addition, a few other significant projects are listed below.

Kaladan Multimodal Transit Transport Project

This project gives India vital access to the area and is a significant component of the Act East agenda. The project's goal is to establish an alternate route between the landlocked North-East and the rest of India by offering alternative connectivity to the North East Region from the Kolkata/Haldia port via Sittwe Port-Kaladan River up to Paletwa in Myanmar via waterway and Paletwa to Zorinpui by road in Mizoram. The key ministry for implementation is the Ministry of External Affairs. For this project, the Project Development Consultant (PDC) is the Inland Waterways Authority of India (IWAI). Although the project's original completion date was set for 2014, it is anticipated that it would be completely operational by March 2023. Additionally, Aizawl and Sittwe Port in Myanmar are connected by the Kaladan Multi-Modal Transit Transport Project (KMMTTP). The project connects Mizoram with the Bay of Bengal deep seaport in Rakhine state, Myanmar, by combining an inland waterway and a highway. It intends to build a 109-kilometer road connecting the Paletwa River port to Zorinpui on the Myanmar-Mizoram border, as well as to improve Sittwe to accommodate 20,000-ton vessels dredging the River Kaladan from Sittwe to Paletwa, a 158-kilometer span.

ASEAN Highway Project

The ASEAN Highway network, which connects to Myanmar at the border town of Moreh via Dimapur, Kohima, and Imphal, and the existing NH-39 & NH-36 of Assam, also offers a road connectivity to Southeast Asian nations. With plans to link Thailand, Laos, Vietnam, Cambodia, Malaysia, and Indonesia with the same highway network, this route takes great significance. Without a doubt, this will alter the current state of the nation's economic development. Between km 91/0 and 162/0, 71 km of NH-36 have already been converted to two lanes with paved shoulders as part of SARDP-NE (Phase-A). Already, the route has been designated as Asian Highway No. 1. Through Myanmar, the 1,360-kilometer India-Myanmar-Thailand Trilateral Highway (IMT) will link Moreh, India, and Mae Sot, Thailand. IMT travels across Assam, Nagaland, and Manipur with the primary purpose of promoting trade inside the ASEAN-India Free Trade Area.

However, India mostly uses sea routes for trade with these nations. Consequently, coastal states such as Andhra Pradesh and Tamilnadu benefit. The Look East Policy does not pay enough attention to the land connectivity between these nations and India via the Northeast Region. Therefore, despite sharing land borders with ASEAN, North-East India has not benefited, according to the authors. However, the North-East of India is thought to be important

under the Act East Policy. It is acknowledged that India and ASEAN are connected by geography. By offering a direct trade corridor between the areas, the India-ASEAN physical connectivity projects, such as the Kaladan Multi-Modal Transit Transport Project and the India-Myanmar-Thailand Trilateral Highway, can help North-East India. This highway will provide an alternative route for trade and business between India and Thailand by connecting them via Burma. The project is expected to be completed by 2024. Myanmar and Thailand will be connected to India through the building of a 1,360-kilometer road that passes through the northeastern provinces of India. It is expected that the initiative will boost business and trade between India and ASEAN countries. The first phase of the three-phase project, which runs from Kalewa in Myanmar to Moreh in Manipur, is complete. The second section, which will connect Kalewa and Yargyi in Myanmar, is now under construction.

Development of National Waterway -2 Project

Inland Water Transport (IWT) has been approved by the Indian government. Projects pertaining to national waterway infrastructure are being developed in the North Eastern Region throughout a five-year period, from 2020–21 to 2024–25. At a cost of Rs. 461 crores, the government is developing Inland Water Transport (IWT) projects on National Waterway-2 (River Brahmaputra) from Dhubri to Sadiya (891 km) over a five-year period (2020–25). The creation of a navigable fairway with day and night navigation aids and terminals is one of the projects' most notable aspects. Through the Indo-Bangladesh Protocol Route, the NW-2 development allows waterway connectivity between the North East area and the ports of Kolkata and Haldia. The construction of the Jogighopa Terminal, an alternate route to Pandu Port, a ship repair facility at Pandu, and tourist jetties at Biswanathghat, Jogighopa, Pandu, and Neamati are the main interventions under this project.

Development of NW-16& IBP route Project

At a cost of Rs. 145 crore, IWT projects are being developed on the National Waterway-16 and IBP route during a five-year period (2020–25) with fairway maintenance, Least Available Depth (LAD), and navigational aids. The process of upgrading the terminals in Badarpur and Karimganj, including the Karimganj terminal's customs and immigration facilities, has begun. This project's main interventions are (i) building a terminal at Sonamura on the Gumti River; (ii) building a terminal at Maia on the Ganga River; and (iii) upgrading the terminals in Badarpur and Karimganj. To enhance connectivity with the North Eastern Region (NER) through waterways, the Prime Minister, the Ministry of Ports, Shipping & Waterways (MoPSW), and the Government of India have undertaken a number of infrastructure projects on National Waterway-1, the Indo-Bangladesh Protocol route, and National Waterway-2 through the Inand Waterways Authority of India (IWAI) in accordance with the Act East policy.

North-East Road and Air Connectivity

This plan seeks to enhance connectivity both within the region and with the rest of India by improving the road infrastructure in the northeastern states. By 2024, the project should be finished. To promote trade and tourism, the Indian government has been attempting to increase air connection to the country's northeastern states. Several airports in the area have been renovated, and new airports are being constructed as part of the government's UDAN (Ude Desh ka Aam Nagrik) initiative to encourage regional air connectivity.

Agartala-Akhaura Rail Link

A railway line known as the Agartala-Akhaura Rail Link will link Akhaura, Bangladesh, and Agartala, Tripura, India. The railway line will encourage trade and tourism in the area while enhancing connectivity between Bangladesh and Northeast India. The project is anticipated to be finished by 2023, with the Indian government having finished 70% of the work as of March 2023. The goal of this project is to build a rail link between Akhaura, Bangladesh, and the Indian city of Agartala. It is anticipated that the project, which entails building a 15-kilometer train route connecting the two cities, will increase economic and interpersonal interactions between the two nations.

Bamboo Development Project

The National Bamboo Mission (NBM) aims to enhance the entire bamboo value chain, from production and processing to market linkages and exports. It does this by funding bamboo development initiatives under India's Act East Policy. Quality Planting Material nurseries, Primary Processing Centers, and Integrated Bamboo Parks are all part of the "Development of Bamboo Value Chain in the North East" initiative, which is being funded by the Asian Development Bank (ADB). These programs aim to increase rural incomes, provide goods to nearby companies, and create economic opportunities for farmers and artisans.

Indo-Bangladesh Coastal Shipping Agreement

Due to this agreement, both nations' coastal vessels are permitted to operate in each other's waters and transport goods to and from India's northeastern states. The deal should increase trade between Bangladesh and India and cut down on time and expense associated with transportation.

Indo-Bangladesh Friendship Pipeline

The India-Bangladesh Friendship Pipeline is a 130-kilometer pipeline that will link Parbatipur, Bangladesh, with Siliguri, West Bengal, India. By carrying diesel from India to Bangladesh, the pipeline will foster energy cooperation between the two nations. The Indian government is scheduled to finish the project by 2023, having finished 80% of the work as of March 2023.

The Indian government is keeping a careful eye on the progress of these projects, which are in varying states of completion. It is anticipated that these initiatives will strengthen links with ASEAN nations and provide the northeastern Indian states with strategic and economic advantages. All things considered, the Act East Policy has greatly advanced Northeast India's connectivity and encouraged trade and tourism. It is anticipated that the completion of the aforementioned projects will further boost the wealth and economic growth of the area.

Conclusion

As of yet, North East India has not seen any noteworthy results from India's expanding relations with South East and East Asian nations. It is imperative that the economic and security conditions in Northeast India improve, and this should be acknowledged as a primary goal of the Act East Policy. Since North East India is a crucial component of the Act East Policy, more appropriate projects and plans must be created. The ongoing initiatives and plans must be carried out effectively, within the allotted time and budget. In the past, North East India was largely unconnected. When the Look East Policy was being implemented, it was essentially ignored.

Therefore, until North East India's economic development is guaranteed, the Act East Policy will not reach its full potential. The Act East Policy should strengthen ties between North East India and its neighbours, such as Bangladesh and Myanmar, and hasten the region's economic development. In addition to changing the focus of interaction from economic concerns to a more comprehensive agenda that includes security cooperation, Act East also envisions the improvement of Northeast India through a number of connections. The Kaladan Multi-Modal Transit Transport Facility, recently agreed upon by India and Myanmar, aims to connect Indian ports on the eastern seaboard with Sittwe Port in Myanmar. From there, it will be possible to transport goods to Northeast India via road and riverine transportation to Mizoram. At the second India-Myanmar border trade point at Rih-Zowkhathar in the Mizoram sector, work is also being done to upgrade the infrastructure, especially the road connections.

In addition to building road connections, work is being done to provide a train connection from Jiribam, Manipur, to Hanoi, Vietnam, via Myanmar, via the border town of Moreh. Direct flights from Guwahati to Imphal, Hanoi, and Ho-Chi Minh City are possible thanks to the Ganga Mekong program. However, the actual state-level infrastructure development work is still unfinished. For the Northeast to gain from the Act East Policy, that is a crucial prerequisite. Additionally, because of their geographic proximity, trade between the Northeastern states of India and the ASEAN nations needs to grow. Any effort to promote deeper connections with the ASEAN nations must also involve the people of this region. When developing measures as part of India's Act East Policy, the central government should also consider the opinions of the chief ministers in this area. The Act East Policy would aid in the creation of peace in this area plagued by insurgency once Northeast India starts to benefit from it.

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Original Article

Challenges of Girls' Education in South Asian Association for Regional Coorporation (SAARC) Nations: A Pathway to Sustainable Development

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Abstract

In promoting sustainable development education plays an important role. It is the fundamental right of human being. In the context of South Asian Association for Regional Coorporation (SAARC), to shape social, economic, and political development of girls, girls' education is very important. Although significant progress in literacy rate has been observed but gender disparities in education is a real problem till this date in various regions. Even today girls are facing various obstacles to pursue their education. This socio economic and cultural barrier is an unavoidable obstacle in the overall progression of SAARC, particularly 'quality education' and 'gender equality'. This paper highlights the main challenges of girls' education in SAARC nations. For sustainable development It focuses on the importance of overcoming all these obstacles that comes on the path of girls' education. This paper will try to explore possible solutions to ensure girls education. It also aims to propose recommendations for ensuring barrier-free girls' education.

Keywords: education, Girls' education, sustainable development, challenges.

Introduction

Key challenges in girls' education in India include pervasive cultural norms that prioritize boys' education, economic hardship leading to child marriage and labour, inadequate school infrastructure such as lack of safe sanitation, safety concerns due to violence and harassment, insufficient number of female teachers, and the digital divide. These factors collectively create significant barriers, making it difficult for many girls to access, stay in, and progress through their education.

Conceptual Framework: Girls' Education and Sustainable Development

In today's context, Girls' education is not just about literacy and schooling. It represents women's empowerment, their participation in the economy and society, and their social transformation. An educated woman can contribute directly to the different aspects of society. For instance, the increase of women's participation in the workforce can bring growth in the economy of the nation. With the increase in girls' education, child marriage can be reduced in society. Girls' education and consciousness can notably reduce maternal and infant mortality.

So it can be said, investing in girls' education is not just a social obligation. It is also an economic and environmental necessity for sustainable development.

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How to cite this article:

Deb, J. (2025). Challenges of Girls' Education in South Asian Association for Regional Coorporation (SAARC) Nations: A Pathway to Sustainable Development. Journal of Research & Development, 17(9(II)), 49–51. https://doi.org/10.5281/zenodo.17578839

Literature Review

Hussain, N. (2020), stated in his study that it as a foundation for expanding women's capabilities and freedoms, while UNESCO (2015) notes its role in reducing poverty, improving health, and fostering economic growth Sperling, H. (2022), highlight how cultural and economic barriers restrict girls' schooling, limiting regional development. Kingdon (2007) observes that in India, early marriage and household responsibilities contribute significantly to female dropout rates.

Asadullah and Chaudhury (2023), found that Bangladesh's stipend programs boosted girls' enrollment, though dropout challenges persist. Similarly, UNICEF (2020) reports that harmful practices in Nepal still affect adolescent girls' education.

Sharma, P. (2025), stated in her study that in SAARC context the status of girld education is poor. Girls have to face many challenges to pursue their minimum education.

Overall, the literature shows that while policy initiatives have expanded access, structural barriers—poverty, cultural norms, and weak implementation—continue to hinder progress. This paper extends the discussion by analyzing these challenges in the SAARC context and identifying opportunities for linking girls' education with sustainable development.

Success Stories:

1. Bangladesh's Female Secondary School Assistance Project (FSSAP): With the support from the World Bank, Bangladesh launched FSSAP in the year 1993. It is considered a milestone in promoting girls' education. This programme provided cash support and tuition to the girls from rural areas with the condition that they will remain unmarried until the completion of their secondary education. This programme notably increased girls' enrolment

2. Self-Help Groups (SHGs) and girls' education: In India, Self Help Groups played an important role in empowering girls' education. Not only livelihood, but SHG has supported girls' education as well. SHG has raised awareness against child marriage. This really helps improve enrolment in school. In some states, with the collaboration of the government and NGOs, SHGs work to ensure scholarships, midday meals, and safe learning environments for the girls.

Findings

Key Challenges of Girls' Education in SAARC Nations

Socio-Economic Barriers

- **Poverty**: In the countries like India, Pakistan, Bangladesh, Afganisthan etc, poverty remains a central challenge. Families having limited income prioritize only boys' education.
- **Child labour:** In some societies girls are expected, often forced to contribute on house hold work. This prevents them from continuing their schooling.

   3.2 Cultural and Gender Norms

- **Patriarchal traditions**: In South Asia, patriarchal traditions often become a struggle in girls' education.
- **Early marriage**: Early marriage and adolescent pregnancy contributes to high dropout rates.

   Infrastructure and Safety

- **Toilet facility**: In rural areas many schools do not have separate toilets for girls. It makes their attendance difficult especially after puberty.
- **Unsafe transportation**: Long travel distances discourage parents from sending daughters to school.

    Quality of Education

- **Lack of female teacher:** Lack of standard education and female teachers weaken the educational outcomes.
- **Gender bias in classrooms**: In some cases, teachers encourage boys to pursue advanced subjects like science and technology and limits girls by discouraging them.

   Policy and Implementation Gaps

- **Weak implementation:** Most SAARC countries have many laws that guarantee girls education. But implementation remains weak due to corruption, lack of monitoring from the grassroot level.
- Political instability in countries like Afghanistan further undermines progress.

Country-Specific Insights

- In India some programs like *Beti Bachao Beti Padhao* and mid-day meal schemes are going on. To some extent improvement in enrolment is notably visible. But due to early marriage and social responsibilities girls often fail to continue their educational jounney.
- Bangladesh achieved progress with female stipend programs. But again, child marriage still disrupts secondary education.
- Bhutan shows relatively better gender parity. But geographical isolation poses access challenges.
- In Nepal cultural practices like *Chhaupadi* (seclusion of menstruating girls) affect attendance in school.
- Pakistan Gender disparity is acute, particularly in rural areas where conservative traditions discourage girls' schooling.
- In Afganistan political situation, especially restrictions under the Taliban, has severely reversed progress in girls' education.
- Maldives and Sri Lanka have relatively higher female literacy rates. But rural-urban gaps persist.

Recommendation

1. Enhance Implementation of Policy – Make the laws enacted on compulsory and free education work.

2. Economic incentives – Increasing the availability of scholarships and cash transfer programmes for families who send girls to school may help to improve girls' literacy rates.

3. Building girl- Friendly schools with latrines, safe transport, female teachers, and infrastructure development will increase the girls' enrolment in schools.

4. Social Mobilisation Campaigns – Discouraging cultural attitudes that limit girls' education can help to promote girls' education. It can be done through social media, awareness programmes, etc.

5. Regional Cooperation – To maximise girls' education, SAARC needs to bring a common educational structure and share the best practices between the members.

6. Digital Inclusion – Investing in digital education tools, especially in remote rural areas, may definitely help to improve girls' education.

Conclusion

The problems of girls' education in SAARC countries like India, Pakistan, Bangladesh, Afghanistan, etc. are the reflections of socio-cultural and economic issues. But it is not possible to achieve sustainable development without countering all those obstacles that fall on the path of girls' education. Girls who receive an education create healthier families. The educated girls are capable of building a stronger economy by participating in the workforce of the nation. By addressing all the obstacles of girls' education, SAARC countries can ensure that girls' education can become a cornerstone of sustainable development. The success of these nations in the 21st century will depend largely on how effectively they empower their daughters through education.

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Original Article

The Role of Banking and Insurance in Addressing Climate Change and Sustainable Growth in SAARC Nations: Challenges and Opportunities

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Abstract

South Asia is among the most climate-vulnerable regions in the world and faces urgent needs for both mitigation and adaptation finance. Banks and insurance companies—through lending, risk transfer, investment, and advisory services—play a central role in mobilizing capital, allocating risk, and shaping incentives that determine whether the region's transition is sustainable and equitable. This paper examines the evolving role of banking and insurance in the eight SAARC nations (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka). It synthesizes regulatory developments (green finance taxonomies, central bank guidelines), private-sector initiatives, and international finance flows; analyzes barriers (institutional, market, data and capacity constraints, exposure to transition and physical risks); and identifies policy and industry interventions to maximize positive outcomes. Using a mixed qualitative methodology—policy/document analysis, synthesis of recent reports, and comparative assessment—the study argues that while progress (green banking guidelines, taxonomies, climate disclosure initiatives) is accelerating, systemic reforms—better risk pricing, scalable insurance solutions, integrated regulatory frameworks, and targeted blended finance—are essential to channel sufficient resources to both adaptation and low-carbon development.

Keywords: climate finance, green banking, insurance, SAARC, sustainable growth, green taxonomy, adaptation finance.

Introduction

South Asia is highly exposed to climate hazards: extreme heat, monsoon variability, glacial melt, sea-level rise and coastal inundation, and intensifying cyclones and floods. These phenomena threaten livelihoods, infrastructure, public finances, and financial sector stability. With constrained fiscal space in many SAARC countries and high development needs, private-sector finance—especially from banks and the insurance industry—must contribute materially to climate mitigation and adaptation. Financial institutions can reallocate capital toward low-carbon investments, underwrite climate risks, offer inclusive risk-transfer products, incentivize green behaviour through pricing and covenants, and support resilient infrastructure and smallholder adaptation. Recent years have seen notable policy and regulatory movement—green banking guidelines, central bank sustainable finance policies, and national taxonomies—across several SAARC jurisdictions, but significant gaps remain in mobilizing sufficient volumes and aligning incentives across public and private stakeholders. This paper examines how banking and insurance are acting—and should act—to address climate change while fostering sustainable growth in SAARC nations.

Objectives

- To map the current landscape of regulatory and industry responses among SAARC nations regarding green finance, climate risk disclosure, and insurance solutions.
- To analyze how banks and insurers can mobilize capital for mitigation and adaptation, including instruments, mechanisms, and institutional arrangements.

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- To identify barriers—financial, institutional, informational, political—that limit effective private-sector climate action in SAARC countries.
- To propose policy, regulatory, and market interventions to scale climate finance through banking and insurance while safeguarding financial stability and social inclusion.
- To provide actionable recommendations for regulators, banks, insurers, multilateral partners, and civil society to accelerate a just transition in the region.

Scope of Study

This paper covers the eight SAARC member states (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka). It focuses on the roles of commercial and development banks, non-bank financial institutions (where relevant), and the insurance sector (life and non-life). Primary emphasis is on policy/regulatory frameworks, industry initiatives, and international finance flows influencing national outcomes. The temporal scope prioritizes developments since around 2015 (Paris Agreement) with particular attention to the most recent policy developments up to mid-2025 (e.g., national taxonomies, central bank guidance, national climate finance strategies). The paper synthesizes secondary sources—central bank circulars and taxonomies, multilateral bank reports, industry analyses, and peer-reviewed and grey literature—and does not rely on primary fieldwork.

Methodology

The study uses a qualitative, comparative method combining:
Document and policy analysis: review of central bank circulars, green finance guidelines, national climate finance strategies, and relevant policy documents from SAARC countries (e.g., Bangladesh Bank's Sustainable Finance Policy; Nepal Rastra Bank's Green Finance Taxonomy; Sri Lanka's Green Finance Taxonomy). Synthesis of international reports: integration of findings from the World Bank, MDB joint climate finance reporting, UNEP FI, and other multilateral and industry analyses to gauge flows and systemic trends.Comparative assessment: cross-country comparison of regulatory instruments (mandatory vs voluntary disclosure, taxonomy adoption, green banking targets), insurance market penetration and products, and innovations in blended finance and public-private partnerships. Evidence triangulation: corroboration of policy claims with news and press releases (e.g., World Bank statements on private-sector led climate resilience in South Asia). Because the region's policy environment is dynamic, the paper prioritizes credible institutional sources and recent (2022–2025) materials for claims about regulatory change and major finance initiatives.

Context: Why Banks & Insurers Matter for SAARC Climate Outcomes

Two key functions make banks and insurers central to climate action:

Intermediation and capital allocation — Banks channel savings into investments. By adjusting risk assessment, collateral requirements, loan covenants, and portfolio strategies, banks can steer capital toward renewable energy, energy efficiency, resilient infrastructure, sustainable agriculture, and climate-smart SMEs. Conversely, continued financing of carbon-intensive assets locks in emissions and stranded asset risk. Recent global evidence shows major banks continue to finance fossil fuels significantly, underscoring the need for credible transition policies and sectoral targets.

Risk transfer and management — Insurers enable risk pooling, pricing, and transfer. For climate adaptation—particularly for smallholders, low-income households, and MSMEs—microinsurance, parametric products, index insurance, and public-private risk pools can improve resilience. The insurance industry also influences behavior through underwriting standards and premiums that reflect climate risks, though market penetration for many SAARC countries remains low and affordability constrained. UNEP FI and other bodies highlight the need for integrated underwriting of climate risks and alignment of insurance portfolios with net-zero and resilience goals. Regulatory and Market Developments in SAARC Countries (Selected Examples) This section highlights representative regulatory developments that shape bank and insurer behaviour.

Bangladesh: Bangladesh Bank has been a pioneer in South Asia on green banking; its Sustainable Finance Policy and prior Green Banking Guidelines set targets and reporting frameworks for banks and FIs, including minimum green lending targets in prior years and structured reporting. These measures increased institutional attention to environmental and social risk management.

India: The Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), and other regulators have increasingly moved on climate disclosure and sustainable finance. India has been developing national taxonomy and draft disclosure frameworks (e.g., RBI's draft "Disclosure Framework on Climate-Related Financial Risks") and broader country-level market mobilization remains strong given India's size. Recent landscape analyses document institutional measures and gaps in scaling finance for adaptation.

Nepal: Nepal Rastra Bank released a Green Finance Taxonomy (2024) to classify environmentally sustainable economic activities and to incentivize aligned financial products—an important step toward standardization and mobilizing private capital.

Sri Lanka: The Central Bank of Sri Lanka introduced a Green Finance Taxonomy (2022) and related sustainable finance initiatives to support climate finance flows and guide financial sector actors.

Pakistan: The State Bank of Pakistan (SBP) has emphasized financial stability risks from climate change and promoted sustainability through supervisory guidance; Pakistan launched a National Climate Finance Strategy (NCFS) as part of efforts to mobilize resources. The SBP's Financial Stability Reports and related documents highlight the centrality of financial sector reforms for climate resilience.

Multilateral signals: Multilateral development banks (MDBs) and the World Bank have increased climate finance commitments to South Asia; recent MDB joint reports and World Bank communications stress need for private sector mobilization for resilience, signaling channels for blended finance and policy reforms.

These examples show regulatory momentum, but implementation, harmonization across jurisdictions, and scaling remain significant hurdles.

Discussion: Key Themes and Analytical Findings

1. Mobilization of Climate Finance — What Banks Can Do

Banks mobilize climate finance through multiple tools:

Green lending and project finance for renewable energy, green infrastructure, and climate-smart agriculture. These can be supported by concessional co-financing, partial credit guarantees, and risk mitigation instruments provided by development partners. Sustainable bonds and loan products (green bonds, sustainability-linked loans) to attract institutional and international investors. Market growth depends on credible taxonomies and transparent use-of-proceeds reporting.

Retail green finance (green mortgages, energy-efficiency loans) to drive household-level mitigation and resilience. Reorientation of credit risk models to incorporate climate physical and transition risks in credit assessment, thus reducing stranded asset exposure and preventing moral hazard. However, banks face barriers: limited project pipelines for bankable climate adaptation projects; weak collateralization in smallholder and MSME contexts; capacity gaps in climate risk assessment; and sometimes short-term profitability pressures. For mobilization to scale, blended finance and catalytic MDB instruments (credit enhancement, guarantees) remain crucial. MDB reporting indicates increased climate finance flows but highlights adaptation funding shortfalls; adaptation financing remains a smaller share of global climate finance, yet is critical for South Asia.

2. Insurance: From Underwriting to Resilience

Insurance in South Asia is uneven: penetration of non-life insurance (property, crop, disaster) is low compared to more developed markets, and microinsurance remains underdeveloped. Insurance interventions that matter include:

Parametric insurance and index products for agriculture and disaster—these provide faster payouts, reduce moral hazard, and are administratively simpler than indemnity insurance.

Public-private risk pools and sovereign risk transfer tools (e.g., catastrophe bonds, regional risk pools) to protect public finances and maintain fiscal space after major disasters.

Insurance-linked lending and project risk coverage to improve bankability of resilient infrastructure and private investment in adaptation.

Insurance penetration and affordability initiatives—subsidies or targeted premium support for the poorest, and integrating insurance with digital payment systems for scale.

Insurers must also adapt: integrate climate scenario analysis into underwriting, develop products for emerging risks (heat stress, supply chain disruptions), and manage their own asset portfolios in line with transition goals (avoiding heavy fossil fuel exposures). UNEP FI highlights the need for the insurance sector to integrate climate risk across underwriting, asset management, and client engagement.

3. Climate Risk and Financial Stability

Climate risks translate into financial stability risks through multiple channels: physical damage to collateral and borrowers' income, market repricing of carbon-intensive assets, and heightened sovereign risk from disaster-related fiscal shocks. Central banks are increasingly embedding climate considerations into prudential supervision, stress testing, and disclosure. The State Bank of Pakistan and other central banks have published analyses and guidance concerning climate risk to the financial system. More systematic climate stress testing—incorporating both physical and transition scenarios—is needed across SAARC to quantify exposures and inform macroprudential responses.

4. Regulatory Tools and Market-Making: Taxonomies, Disclosure, and Targets

National taxonomies (Nepal, Sri Lanka, and growing work in India) and central bank guidance help define eligible green activities, reduce greenwashing, and provide a common language for investors and issuers. Disclosure frameworks—aligned with TCFD/ISSB principles—enable market discipline and better pricing of climate risks. However, fragmentation across jurisdictions and voluntary compliance limits cross-border investment flows. Harmonization, regional principles, and technical assistance would help scale cross-border green finance within South Asia.

5. Inclusion and Social Equity: Ensuring a Just Transition

Banking and insurance solutions must be inclusive. Smallholders, informal workers, and urban poor are most exposed but often lack access to formal finance or insurance. Solutions include tailored microfinance coupled with climate advisory services, bundled insurance (credit + index insurance), concessional finance for resilient livelihoods, and community-based risk pooling. Policies should avoid placing adaptation burdens on those least able to pay and incorporate gender and social safeguards in product design.

6. Data, Capacity, and Digital Innovation

Effective climate finance requires high-quality, geo-referenced risk data and institutional capacity for climate risk analytics. Digital finance and fintech can reduce transaction costs, enable parametric triggers (using satellite, weather or meter data), and expand distribution. Yet data gaps (granular hazard exposures, loss histories) and limited in-house analytics capacity constrain product innovation.

7. Role of International and Regional Cooperation

Multilateral development banks, bilateral partners, and climate funds are essential for de-risking private investment and providing adaptation concessional capital. MDB joint reporting indicates rising climate finance flows but stresses that public budgets alone cannot meet the need; private sector mobilization is a policy priority. The World Bank and MDB engagements emphasize private sector leadership combined with policy reforms to leverage greater private finance for resilience and mitigation in South Asia.

Major Barriers (Synthesis)

Insufficient bankable adaptation project pipelines (especially for decentralized, smallholder projects).
`Weak insurance penetration and market depth, limiting private risk transfer for large vulnerable populations.
Data and capacity gaps for climate risk assessment, resulting in inconsistent pricing and underestimation of exposures.Regulatory fragmentation and lack of harmonized taxonomies, which hamper cross-border capital flows and investor confidence.Fossil-fuel financing persistence among banks globally—locking in emissions pathways and exposing portfolios to transition risk.

Opportunities & Policy Recommendations

Below are prioritized actions to strengthen the role of banking and insurance for climate resilience and sustainable growth.

A. For Regulators and Policymakers

Adopt and harmonize green finance taxonomies and disclosure standards—while allowing country specificity, aim for regional comparability to attract cross-border capital. (Nepal, Sri Lanka, and steps in India provide models).
Mandate climate risk disclosure phased in with capacity building—aligning with TCFD/ISSB principles to improve market discipline and enable stress testing.
Enable blended finance instruments and partial credit guarantees to de-risk private investment in adaptation and resilient infrastructure, leveraging MDB capital.
Promote micro- and parametric insurance markets via regulatory sandboxes, public premium support during early scaling, and integration with social protection systems.
Mainstream climate into prudential supervision—incorporate climate scenario analysis in bank supervision, require climate risk management units, and encourage green asset ratio reporting.

B. For Banks and Financial Institutions

Integrate climate into credit risk frameworks—score borrowers for physical and transition exposures; price risk and use covenants to incentivize mitigation/adaptation investments.
Develop retail green products and bundled finance (e.g., EE loans linked to green mortgages, agricultural loans bundled with weather index insurance). Leverage digital platforms for product distribution, monitoring, and parametric triggers—reducing costs and improving inclusion. Engage in corporate transition planning and align balance-sheet asset management with net-zero pathways to manage long-term risk.

C. For Insurers

Scale parametric/index insurance and microinsurance for agriculture, fisheries, and urban climate hazards; combine with climate advisories and early warning systems.

Develop sovereign risk-transfer instruments and regional pools for catastrophic risks, supplementing domestic capacity.

Adjust underwriting and asset management to reflect climate exposures and support client transition through risk pricing and product innovation.

D. For International Partners and MDBs

Provide catalytic capital and guarantees to mobilize private investment, especially for adaptation where returns are lower and risks higher. MDB joint reports and World Bank strategies emphasize the importance of private sector mobilization for resilience.

Support capacity building and data infrastructures (hazard mapping, loss databases, climate scenario tools) for national regulators and financial institutions.

Promote regional cooperation platforms to harmonize taxonomies, share best practices, and coordinate cross-border instruments.

Case Examples (Brief)

Bangladesh has long used bank regulatory incentives (green banking guidelines) and is piloting crop insurance and parametric products in some regions; the combination of policy and market instruments offers lessons for scaling inclusive insurance.

Nepal & Sri Lanka: National green taxonomies (2024 & 2022 respectively) are steps toward standardizing eligible activities for green finance, enabling clearer use-of-proceeds for bonds and loans.

Pakistan: The National Climate Finance Strategy (2024) and SBP emphasis on climate risks highlight ongoing institutional reform to mobilize finance and manage systemic risk.

Regional MDB efforts: World Bank and MDB commitments signal potential for blended instruments to catalyze private flows for resilience across South Asia; they stress private sector-led adaptation with enabling policy reforms.

Conclusion

Banks and insurers have indispensable roles in supporting climate mitigation, adaptation, and inclusive sustainable growth in SAARC nations. Regulatory progress—green banking guidelines, taxonomies, and disclosure drafts—alongside MDB signals, reflect strong momentum. Yet, to close the finance gap and protect economic development, the region must scale bankable adaptation pipelines, deepen insurance markets, harmonize regulatory frameworks, build climate risk data and capacity, and design inclusive products for vulnerable populations.

Findings

- Regulatory progress is visible but uneven: Several SAARC countries (Bangladesh, Nepal, Sri Lanka, India) have issued green finance guidelines or taxonomies, but implementation and harmonization lag.
- Adaptation finance remains underprovided: MDB reporting shows growth in climate finance but adaptation finance is still comparatively low versus mitigation, even though South Asia's adaptation needs are acute.
- Banks can mobilize capital but need pipeline & risk mitigation: Banks require bankable projects, blended finance, and risk-sharing instruments to scale adaptation and resilient infrastructure lending.
- Insurance markets are weak but high-impact innovations exist: Parametric insurance and public-private risk pools provide pathways to protect vulnerable populations and sovereign finances—yet affordability and distribution remain obstacles.
- Climate risk constitutes a financial stability concern: Central banks and supervisors must integrate climate into macroprudential frameworks and stress testing to preserve financial stability and ensure orderly transitions.
- Private sector mobilization is essential: Recent World Bank guidance emphasizes private-sector led resilience as necessary given constrained public budgets; MDB catalytic instruments are crucial for unlocking private capital at scale.

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12. If you'd like, I can now:

Original Article

Biodiversity Assessment and Calorific Value of Forest Crops in the Nagpur Forest Division

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Abstract

Teak (Tectona grandis) is a globally prized, prosperous hardwood timber, naturally found across South and Southeast Asia, including a large natural distribution in India. To compensate for the decline of natural forests, India established its first teak plantation in Kerala in 1842, a practice that has become common nationwide, particularly in states such as Madhya Pradesh, Maharashtra, Karnataka, Tamil Nadu, and Kerala. Indian teak wood's key characteristics include a natural golden-brown color, a distinctive leather-like smell from its natural oils, high density and hardness, and impressive durability. It's highly resistant to moisture, warping, cracking, and termite infestations, making it excellent for outdoor use and furniture. Teak also has a straight, visually appealing grain pattern and can be easily polished. Teak wood has a higher calorific value than many common wood species. Its high oil and extractive content primarily influence its energy content. With the growing importance of forest biomass as a source of clean, renewable energy, this study aims to evaluate the net calorific values of wood from key tree species in the Nagpur forest division. The selection of species for analysis is based on forest inventories, which highlight the prevalence of commercially important Tectona grandis (teak), as well as other significant species.

Keywords: *Teak, Hardwood timber, Plantations, Forest biomass, Calorific value.*

Introduction

India's megadiverse status, encompassing 8% of global biodiversity, is reflected in its vast area of 328.73 million ha, making it the seventh largest country. About one-fifth of India's geographical area is covered with forests, and approximately 45,000 plant species exist in India. The commercially important tree *Tectona grandis* (Teak) is classified within the Lamiaceae family and is a major species used in tree plantations, which is naturally distributed in India. (K.Palanisami et.el (2009). India possesses the world's most extensive collection of teak genetic resources. *In India, Tectona grandis forests are widely distributed in Maharashtra, Madhya Pradesh, Tamil Nadu, and Karnataka.* Kerala, Uttar Pradesh, Gujarat, Orissa, and Rajasthan. *(India State Forest Report 2023)*

The calorific value measures the energy from burning one unit of a fuel, but this value decreases with wood's moisture content, as energy is lost to evaporating water. For teak wood, its calorific value is important for determining its potential as a biofuel, with the energy released upon combustion being influenced by the wood's internal chemical makeup and external factors like its growing conditions.

Study Area

Figure 1: Map of the study area.

Forest area (Ha)

Figure 2: Range-wise distribution of Nagpur Forest Division.

The present study is based on the forest area of Nagpur division. The forest areas occur in compact blocks as well as in scattered patches within the civil territory of Nagpur District of the State of Maharashtra. The area lies between the parallels of 20^0 35" and 21^0 44" N and 44" N and the longitudes of 78^0 15" and 79^0 40" E.

Configuration of the ground

Nagpur Forest division lies at the southern fringe of the Satpura Range. The greater part is undulating, plain, and is traversed by low hill ranges. It is hilly in the north–east and has an average elevation of about 300 m above mean sea level. Altitude varies from 204.04 m. to 615 m. The Division is well-drained and falls within the catchments of the Wardha and Wainganga rivers. There are ancient crystalline rocks mainly consisting of gneiss and granulite lying in the North and East portions. The Deccan Trap volcanic flow lies in the western and southern part of the division. In addition, many sedimentary rock formations, including some coal-bearing beds, are also found. The soils in the division can be broadly divided into the following six classes:

(1) Black soil, (2) Morand, (3) Khardi, (4) Bardi, (5) Kachhar, and (6) Wardi.

1.   Climatic parameters:

The climate is characterised by a hot summer, well-distributed rainfall, and dryness except in the rainy season. The cold season is from December to February and is followed by the hot season from March to May. The southwest monsoon season is from June to September, while the period from October to November constitutes the post-monsoon season. The average annual rainfall is 1101.4 mm. The average annual temperature in the district is 27 ^{0}C. *(Nagpur District Gazetteer 24-25)*

Materials and Methods

1.   Biodiversity Assessment

The method of systematic line plot sampling is used for biodiversity assessment. A total of 367 sample plots, each measuring 31.62m x 31.62m (or 0.1 ha), were established at the intersections of a 750m x 750m grid. Trees within these plots were counted, and their girth was measured in uniform classes of 15cm. Using the enumeration data, species-specific girth and density distribution were calculated. A biodiversity assessment, including species density, frequency, basal area, dominance, and the Importance Value Index (IVI), were calculated for all tree species. The biodiversity assessment identified the major tree species within the division. These findings guided the selection of specific species, including Tectona grandis, for further calculations of calorific values.
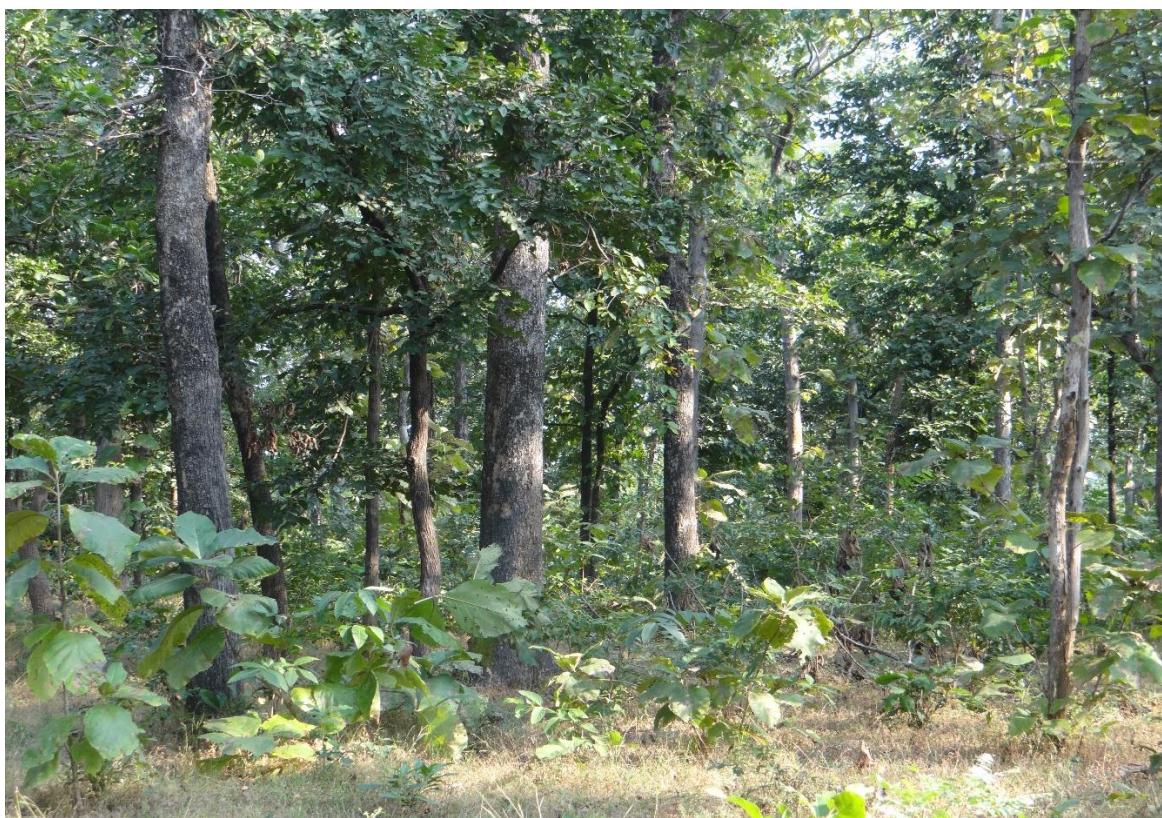
Figure 3: Representative forest area for biodiversity assessment.

2.   Calorific Value Determination:

The wood samples collected are ground finely and then converted into pellets with the help of a pellet-making machine. To determine the calorific value of wood with a bomb calorimeter, a precisely weighed wood pellet sample is placed in a crucible inside the sealed bomb, which is then filled with pure oxygen under high pressure. The

bomb is submerged in a known mass of water in a copper calorimeter equipped with a stirrer and thermometer. A fine fuse wire, ignited electrically, burns the wood sample, releasing heat. This heat raises the surrounding water's temperature, which is measured. The temperature change, along with the known mass of the wood sample and the calorimeter's specific heat capacity, allows for the calculation of the wood's calorific value. The calorific value is calculated using the formula: Calorific Value (CV) = (m_water × C_water × ΔT - w_wire × q_wire) / m_sample

Where:

m_water: Mass of water.

C_water: Specific heat capacity of water.

ΔT: Temperature change (Tf - Ti).

w_wire: Mass of the fuse wire.

q_wire: Calorific value of the fuse wire (known).

m_sample: Mass of the wood sample.

Figure 4: Pellets prepared from a fine wood sample.

Figure 5: Determination of calorific value by using a bomb calorimeter

Results and discussion

It was found that the forests of the Nagpur Forest Project division belong to the Subgroup 5A – Southern Tropical Dry Deciduous Forests as per the revised classification of 'Champion and Seth'. The site quality of the Forests varies from II/III to IV, with crown density varying from 0.2 to 0.8.

1. **Floristics Composition**: - The area of this division is rich in flora. The floristic composition of the area is as follows.

Sr. No.	Species	Number of Trees Per Ha.
		Girth-wise Classification of Trees in cm.	
		15-30	31-45	46-60	61-75	76-90	91-105	106-120	121-135	135-150	Above 150	Total
\multicolumn{2}{c}{Basal Area Factor in sq m.}	0.0042	0.0115	0.0224	0.0368	0.0549	0.0765	0.1017	0.1314	0.1628	0.2102	
1	*Tectona grandis*	41.44	29.03	20.63	13.79	8.56	4.36	2.15	0.65	0	0	120.61
2	*Terminalia tomentosa*	8.47	5.9	5.66	3.74	2	1.46	0.35	0.36	0.16	0	28.10
3	*Tamarindus arjuna*	0.03	0	0.1	0.02	0	0	0.03	0	0.11	0	0.29
4	*Pterocarpus marsupium*	0.2	0.06	0.37	0.32	0.13	0.12	0.02	0.06	0.05	0	1.33
5	*Chloroxylon swietenia.*	12.13	7.09	3.42	1.67	1	0.49	0.11	0	0	0.05	25.96
6	*Aegle marmelos*	2.45	1.17	1.21	1.28	0.82	0.21	0.22	0	0.02	0.02	7.40
7	*Hardwickia binata*	1.17	1.86	0.95	0.05	0.05	0	0.02	0	0	0	4.10
8	*Terminalia bellerica*	0.33	0.3	0.21	0.27	0.38	0.22	0.06	0	0	0	1.77
9	*Buchanania lanzan*	7.92	2.78	1.08	0.44	0.33	0.11	0.11	0.05	0	0	12.82
10	*Albizzia odoratissima*	0.03	0.13	0.03	0.03	0.08	0	0	0.02	0	0	0.32
11	*Anogeissus latifolia*	3.1	2	1.49	0.93	0.54	0.93	0.46	0.28	0	0	9.73
12	*Grewia tiliaefolia*	0.27	0.44	0.23	0.11	0	0	0	0	0	0	1.05
13	*Cleistanthus collinus*	3.89	2.01	1.61	0.34	0.16	0.06	0	0	0	0	8.07
14	*Cochlospermum religiosum*	3.38	2.05	0.91	0.2	0.06	0	0	0	0	0	6.60
15	*Adina cordifolia*	0.14	0.03	0.02	0	0.02	0	0	0	0	0	0.21
16	*Acacia catechu*	3.22	3.11	3.62	1.07	0.33	0.02	0	0	0	0	11.37
17	*Schleichera oleosa*	0.36	0.32	0.12	0.08	0.05	0	0.02	0	0	0	0.95
18	*Mitragyna parviflora*	0.06	0.17	0.14	0.34	0.11	0.12	0	0	0	0.02	0.96
19	*Miliusa velutina*	3.54	2.29	1.17	0.57	0.14	0.03	0.02	0	0	0	7.76
20	*Holarrhena antidysenterica*	3.22	0.57	0.27	0.06	0.05	0.26	0.2	0	0	0	4.63
21	*Lagerstroemia parviflora*	10.53	2.75	1.06	0.33	0.14	0.14	0	0	0	0	14.95
22	*Lannea coromandelica*	0.83	1.66	1.22	1.59	0.63	0.8	0.4	0.11	0.16	0.06	7.46
23	*Madhuca indica*	1.59	1.32	0.8	0.9	0.51	0.33	0.45	0.17	0.13	0.35	6.55
24	*Butea monosperma*	6.44	5.63	3.63	1.44	0.76	0.14	0.14	0.05	0	0	18.23
25	*Soymida febrifuga*	0.65	0.67	0.44	0.32	0.62	0.44	0.5	0.14	0.11	0	3.89
26	*Boswellia serrata*	0.29	0.34	0.16	0.09	0.06	0.11	0.24	0.05	0.02	0	1.36
27	*Bombax ceiba*	0	0.02	0	0.06	0	0	0	0	0	0	0.08
28	*Dalbergia latifolia*	0.07	0	0.05	0	0	0	0	0	0	0	0.12
29	*Ougennia oogenesis*	0.03	0.03	0.02	0	0	0	0	0	0	0	0.08
30	*Diospyros melanoxylon*	14.87	2.68	1.12	0.75	0.45	0.33	0.15	0.05	0	0	20.40
31	Other	39.28	18.73	9.27	5.31	2.41	1.85	1.04	0.39	0.43	1.05	79.76
\multicolumn{2}{c}{**Total**}	169.93	95.14	61.01	36.1	20.39	12.53	6.69	2.38	1.19	1.55	406.91
\multicolumn{2}{c}{Basal Area in Sq.m. per ha.}	0.71	1.09	1.37	1.33	1.12	0.96	0.68	0.31	0.19	0.32	**8.09**

Table 1: The floristic composition of the Nagpur Forest division

2. Biodiversity Assessment: -

A biodiversity assessment was conducted in a forest division using data from 367 sample plots, covering 0.18% of the total area. This involved enumerating individual trees and measuring their Diameter at Breast Height (DBH), Relative Density, Frequency and Basal Area to calculate several key attributes including the Important Value Index (IVI).

Sr. No.	Species	No. of trees per ha.	Relative Density	Relative Frequency	Relative Basal Area	IVI
1	*Tectona grandis*	120.6	29.64	10.13	32.01	71.78
2	*Terminalia tomentosa*	28.11	6.90	6.09	8.65	21.65
3	*Tamarindus arjuna*	0.29	0.07	0.34	0.25	0.66
4	*Pterocarpus marsupium*	1.33	0.33	1.43	0.74	2.50
5	*Chloroxylon swietenia.*	25.95	6.38	7.69	4.70	18.77
6	*Aegle marmelos*	7.38	1.82	1.43	2.35	5.60
7	*Hardwickia binata*	4.09	1.00	1.09	0.62	2.71
8	*Terminalia bellerica*	1.78	0.44	0.67	0.74	1.85
9	*Buchanania lanzan*	12.81	3.15	2.35	1.85	7.35
10	*Albizzia odoratissima*	0.31	0.08	0.38	0.12	0.58
11	*Anogeissus latifolia*	9.73	2.39	7.90	3.58	13.87
12	*Grewia tiliaefolia*	1.05	0.26	0.97	0.25	1.47
13	*Cleistanthus collinus*	8.07	1.98	4.54	1.24	7.76
14	*Cochlospermum religiosum*	6.61	1.62	0.88	0.87	3.37
15	*Adina cordifolia*	0.2	0.05	0.29	0.03	0.38
16	*Acacia catechu*	11.37	2.79	4.45	2.35	9.59
17	*Mitragyna parviflora*	0.95	0.23	0.59	0.25	1.07
18	*Miliusa velutina*	0.96	0.23	0.55	0.49	1.28
19	*Holarrhena antidysenterica*	7.76	1.91	4.08	1.24	7.22
20	*Buchanania lanzan*	4.62	1.14	2.06	0.87	4.06
21	*Lagerstroemia parviflora*	14.95	3.68	6.30	1.61	11.59
22	*Lannea coromandelica*	7.47	1.83	2.10	0.37	4.31
23	*Madhuca indica*	6.54	1.61	2.61	3.58	7.80
24	*Butea monosperma*	18.23	4.48	3.87	3.71	12.05
25	*Soymida febrifuga*	3.88	0.96	2.06	2.35	5.36
26	*Boswellia serrata*	1.37	0.33	0.50	0.74	1.58
27	*Bombax ceiba*	0.08	0.02	0.25	0.03	0.30
28	*Dalbergia latifolia*	0.12	0.03	0.13	0.02	0.17
29	*Ougennia oogenesis*	0.08	0.02	0.08	0.01	0.12
30	*Diospyros melanoxylon*	20.39	5.02	8.78	2.72	16.52
31	Other	79.75	19.60	15.42	18.54	53.56
	Total	**406.82**				

Table 2: Ecological parameters of the species of the Nagpur Forest division

The results show that the frequency of all main species is high, with Tectona grandis having the highest frequency of 10.13, followed by Diospyros melanoxylon. The lowest frequency is 0.08 of Ougennia oogenesis, followed by Dalbergia latifolia. The maximum basal area is occupied by Tectona grandis in all the forest. When judged from the important value index again, Tectona grandis has the maximum value of 71.78, whereas Ougennia oogenesis has the minimum value of 0.12.

3. Calorific Value determination

Based on enumeration data and biodiversity assessment, species-wise calorific value was calculated using a bomb calorimeter, and is found as under:

Sr. No.	Species Name	Calorific value MJ/kg
1	*Tectona grandis*	20.2
2	*Terminalia tomentosa*	18.6
3	Terminalia *arjuna*	5.03
4	*Pterocarpus marsupium*	19.7
5	*Chloroxylon swietenia.*	21.51
6	*Aegle marmelos*	20.4
7	*Hardwickia binata*	20.5
8	*Terminalia bellerica*	20.9
9	*Buchanania lanzan*	25.3
10	*Albizzia odoratissima*	18.15
11	*Anogeissus latifolia*	16.6
12	*Grewia tiliaefolia*	16.0
13	*Cleistanthus collinus*	19.1
14	*Cochlospermum religiosum*	17
15	*Adina cordifolia*	20.24
16	*Acacia catechu*	22
17	*Mitragyna parviflora*	15
18	*Miliusa velutina*	10
19	*Holarrhena antidysenterica*	14
20	*Buchanania lanzan*	27.2
21	*Lagerstroemia parviflora*	18
22	*Lannea coromandelica*	18.3
23	*Madhuca indica*	15
24	*Butea monosperma*	20.4
25	*Soymida febrifuga*	18
26	*Boswellia serrata*	18.2
27	*Bombax ceiba*	20
28	*Dalbergia latifolia*	21
29	*Ougennia oogeinensis*	20.5
30	*Diospyros melanoxylon*	20.1

Table 3: Calorific values of the species of the Nagpur Forest division.

The results show that the Tectona grandis having the highest frequency in the forest area of the Nagpur division having calorific value of 20.2 MJ/Kg, Buchanania lanzan having highest calorific value that is 27.2 and overall rage of calorific values of different species is 5.02 to 27.2. The high calorific value of wood pellets signifies greater energy efficiency, higher heat output, and cost-effectiveness compared to lower-grade alternatives and traditional fuels. A high calorific value means that more heat is generated per unit of fuel burned. The high calorific value of teak wood signifies a superior energy output, making it a highly efficient and cost-effective biofuel, like other biofuel species.

Conclusion

This study concludes that the area of Nagpur Forest division is rich with floral biodiversity. Biodiversity assessments and calorific values provide a powerful and nuanced understanding of an ecosystem's health, its potential for biomass and energy production, and its capacity to sustain different species, including humans. By themselves, the two metrics offer valuable but limited information; together, they reveal insights into ecological dynamics, resource allocation, and resilience.

Conflict of interest

None

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Original Article

Invasion Ecology of Freshwater Fishes: Insights from Morshi Taluka, Maharashtra

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Abstract

Freshwater ecosystems are biodiversity hotspots that provide essential ecological services but are increasingly threatened by invasive alien species (IAS). This paper examines the invasion ecology of freshwater fishes in Morshi Taluka, Amravati District, Maharashtra, India, with a focus on ecological alterations caused by Oreochromis mossambicus (Mozambique tilapia) and Clarias gariepinus (African catfish). Field surveys across 12 sites (reservoirs, lakes, and rivers) documented shifts in fish community structure, abundance, and diversity indices. Results revealed a sharp decline in native fish richness and evenness at sites heavily invaded by tilapia and catfish. Shannon diversity index was significantly lower in invaded habitats (H' = 1.85) compared to relatively undisturbed ones (H' = 2.73). Invasive species biomass accounted for up to 60% of fish yield in certain reservoirs. Ecological consequences included reduced recruitment of native carps, altered trophic interactions, and potential long-term risks to ecosystem services and fisheries-based livelihoods. This study underscores the need for policy-driven ecological monitoring, invasive control strategies, and community awareness to safeguard India's freshwater biodiversity.

Keywords: *invasive species, freshwater biodiversity, fish ecology, ecosystem alterations, Morshi Taluka, ecological management*

Introduction

Freshwater ecosystems—rivers, lakes, wetlands, and reservoirs—cover less than 1% of Earth's surface but sustain nearly 10% of all described species (Dudgeon et al., 2006). They provide critical ecological services such as nutrient cycling, carbon sequestration, water purification, and food security for millions of people. Despite their importance, freshwater habitats are among the most threatened globally, facing challenges from pollution, hydrological alteration, overexploitation, and, increasingly, biological invasions (Strayer, 2010).Invasive alien species (IAS) are organisms introduced beyond their native ranges that establish, spread, and cause ecological or socio-economic harm (IUCN, 2000). In aquatic systems, invasive fishes have become drivers of biodiversity decline, second only to habitat loss. They compete for food and habitat, predate on indigenous fauna, alter nutrient cycles, and disrupt ecological balance (Canonico et al., 2005). India, home to nearly 1000 freshwater fish species, is no exception. The country has witnessed rapid introductions of exotic fishes for aquaculture (e.g., *Oreochromis*, *Cyprinus*), ornamental trade, and accidental escapes. Many of these introductions have become invasive, threatening endemic fishes and aquatic food webs (Singh & Lakra, 2011).Morshi Taluka in Amravati District, located in the upper Wardha River basin of central India, supports a network of reservoirs, rivers, and village lakes. Traditional capture fisheries and small-scale aquaculture play important roles in local livelihoods. However, reports of declining catches of native carps and predatory fishes have coincided with the spread of invasive tilapia (*O. mossambicus*) and African catfish (*C. gariepinus*).

Both species exhibit traits such as rapid growth, high fecundity, environmental tolerance, and aggressive behavior, enabling them to dominate invaded ecosystems (Lowe et al., 2000).

Objectives of the study
1. To document fish species composition in freshwater bodies of Morshi Taluka.
2. To evaluate the ecological impact of invasive fishes on native biodiversity.
3. To analyze shifts in community structure using diversity indices.
4. To recommend conservation and management strategies for sustainable fisheries.

2. Materials and Methods

1 Study Area

Morshi Taluka lies in the **north-eastern Amravati District, Maharashtra**, covering ~900 km² within the upper Wardha basin. The region experiences a **tropical monsoon climate**, with seasonal rainfall (800–1000 mm annually) influencing fish breeding cycles. Study sites included:

- **5 reservoirs** (Ambada, Mozari, Loni, Kholapur, and Rahatgaon)
- **4 lakes** (Triveni, Chandur, Kurha, and Hatgaon)
- **3 river stretches** of the Wardha River

These water bodies support artisanal fishing, irrigation, and domestic use.

2 Sampling and Data Collection

Surveys were carried out between **January 2024 and July 2025**, covering pre-monsoon, monsoon, and post-monsoon seasons. Standardized gear was used:

- **Gill nets (20–80 mm mesh)** for medium–large fishes
- **Cast nets** for smaller shoaling species
- **Traps and hand nets** for benthic and nocturnal species

Fish were identified using **taxonomic keys (Froese & Pauly, 2023)**. Each species was classified as native or invasive. **Abundance, biomass, and frequency of occurrence** were recorded.

3 Data Analysis

Ecological indices were calculated for each site:

- **Species Richness (S)** – number of species
- **Shannon-Wiener Index (H')** – species diversity
- **Simpson's Dominance Index (D)** – dominance of a few species
- **Pielou's Evenness (J')** – distribution uniformity

Statistical tests (ANOVA, t-test) were applied using **SPSS v26**, with significance at $p < 0.05$.

3. Results

1 Fish Species Composition

Across 12 sites, **32 fish species** were recorded, including 26 natives and 6 invasives.

- **Native species (examples):** *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Channa punctata*, *Mystus vittatus*, *Ompok bimaculatus*
- **Invasive species (key):** *Oreochromis mossambicus*, *Clarias gariepinus*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*

2 Impact of Invasive Species

- **Tilapia-dominated sites** showed **40–50% decline** in native herbivores and omnivores.
- **African catfish predation** caused ~35% reduction in carp juveniles.
- Invasive biomass made up to **60% of fish yield** in Mozari and Ambada reservoirs.
- Native carnivores (*Channa marulius*, *Wallago attu*) were displaced in invaded sites.

3 Diversity Indices

Site	Total Species	Native	Invasive	Dominant Invasive	Shannon Index (H')	Simpson's D
Ambada servoir	15	9	6	*O. mossambicus*	1.85	0.42
WardhaRiver (stretch 1)	18	14	4	*C. gariepinus*	2.3	0.25
Triveni Lake	12	7	5	*O. mossambicus*	1.65	0.48
Mozari eservoir	10	6	4	*C. gariepinus*	1.55	0.51

Key trends:
- Mean Shannon index significantly lower in invaded sites (1.85) vs undisturbed (2.73).
- Simpson's dominance higher in invaded sites (0.42) vs non-invaded (0.21).
- Evenness index (J') reflected **skewed dominance** in invaded reservoirs.

Discussion

This study demonstrates that invasive fishes have **reshaped freshwater communities** in Morshi Taluka. The dominance of tilapia and catfish mirrors global trends where invasives disrupt ecological balance (Canonico et al., 2005).

1 Mechanisms of Invasiveness
- **High fecundity** – multiple breeding cycles annually.
- **Environmental tolerance** – survival under low oxygen, fluctuating pH.
- **Predatory pressure** – African catfish consume fish eggs, juveniles, and even amphibians.
- **Competition** – Tilapia monopolizes planktonic and benthic food resources.

2 Ecological Consequences
1. **Decline of native carps** reduces biodiversity and impacts nutrient cycling.
2. **Altered food webs** may increase algal blooms, as herbivorous natives decline.
3. **Loss of ecosystem services** – purification, regulation, and productivity are compromised.
4. **Local fisheries at risk** – fishers report declining catches of market-preferred natives.

3 Socio-economic Implications
- Reduced income for artisanal fishers.
- Market shift towards invasive fish, though less preferred by consumers.
- Potential food security issues if native stocks collapse.

4 Management Recommendations
- **Regulation:** Ban intentional introduction of *C. gariepinus* and restrict tilapia farming.
- **Restoration:** Promote native species restocking (carps, snakeheads).
- **Community awareness:** Involve local fishers in biodiversity conservation.
- **Monitoring programs:** Long-term ecological surveillance with local universities.

Conclusion

The invasion of *O. mossambicus* and *C. gariepinus* has **significantly altered freshwater ecosystems** of Morshi Taluka. Key outcomes include:
- Decline in native richness and evenness.
- Biomass dominance by invasives.
- Altered trophic interactions and fisheries decline.

Urgent action is required, integrating **policy, science, and community participation**, to safeguard freshwater biodiversity and sustain livelihoods.

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Original Article

Adaptive Learning-Based Fuzzy Parameter Adjustment for Real-Time Robust Control under Uncertain Operating Conditions

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Abstract

Control systems in modern engineering applications are increasingly required to operate reliably under dynamic, uncertain, and nonlinear environments. Conventional control strategies, such as proportional–integral–derivative (PID) controllers, offer satisfactory performance only within narrow operating ranges and often deteriorate under disturbances, parameter variations, and unmodeled dynamics. Fuzzy logic controllers (FLCs) have been widely adopted to address system uncertainties by mimicking human decision-making through rule-based reasoning. However, traditional FLCs rely on fixed membership functions and rule weights, which limit their adaptability and degrade performance in rapidly changing environments. To overcome these limitations, this research proposes an adaptive learning-based mechanism that automatically adjusts fuzzy parameters in real time. The mechanism integrates an online learning algorithm with fuzzy control, enabling continuous monitoring of system performance and dynamic modification of membership functions, scaling factors, and rule priorities. Unlike static fuzzy systems, the adaptive model self-tunes its parameters to maintain robustness, stability, and efficiency under diverse operating conditions. The proposed adaptive fuzzy controller is designed to handle nonlinearities, external disturbances, and time-varying uncertainties that are typically encountered in practical applications such as robotics, renewable energy systems, and industrial automation. Simulation studies are conducted on benchmark nonlinear systems to validate the effectiveness of the approach. The results indicate significant improvements in convergence speed, disturbance rejection, and steady-state error minimization compared to conventional PID and static fuzzy controllers. Moreover, the adaptive mechanism enhances system resilience by ensuring consistent control quality even when operating parameters deviate from nominal conditions. This study highlights the potential of integrating adaptive learning strategies with fuzzy logic control to create intelligent, self-tuning controllers suitable for complex and uncertain environments. The proposed methodology contributes toward advancing the field of intelligent control by offering a scalable, real-time, and robust solution that can be extended to a wide range of engineering systems.

Keywords: *Adaptive fuzzy control, real-time learning, parameter adjustment, robust control, system uncertainties, nonlinear dynamics, intelligent control systems*

Introduction:

1. Background and Motivation

Control systems form the backbone of modern engineering and industrial applications, ranging from process control in chemical plants and power systems to robotics, autonomous vehicles, and renewable energy integration. The effectiveness of any control strategy depends on its ability to ensure system stability, accuracy, and robustness in the presence of nonlinearities, uncertainties, and external disturbances [1-4]. While classical controllers such as proportional–integral–derivative (PID) controllers have dominated industrial applications due to their simplicity and effectiveness under well-defined conditions, their performance often deteriorates when systems are exposed to parameter variations, modeling inaccuracies, or unpredictable environmental changes [5-8].

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Fuzzy logic control (FLC), introduced by Zadeh in the 1960s, emerged as an attractive alternative to conventional controllers because of its ability to handle uncertainties and nonlinearities without requiring an explicit mathematical model. By mimicking human reasoning through rule-based decision-making, FLCs provide a flexible framework that can approximate nonlinear functions and adapt to complex system behaviors. Over the past decades, fuzzy controllers have been widely applied in domains such as robotics, energy systems, transportation, and biomedical engineering, where uncertainty and variability are inherent. Despite their advantages, traditional fuzzy controllers often rely on fixed membership functions, rule sets, and scaling parameters. These static parameters are typically designed offline by experts or through trial-and-error tuning and remain unchanged during system operation [9-11]. As a result, when the system encounters sudden disturbances, dynamic nonlinearities, or time-varying conditions, the fuzzy controller's performance may degrade significantly. This lack of real-time adaptability limits the broader applicability of fuzzy controllers in scenarios that demand resilience and robustness [12-15].

2. Problem Statement

The core limitation of static fuzzy control lies in its inability to adapt to variations during real-time operation. For example, in an autonomous vehicle operating under different road and weather conditions, or in renewable energy systems where wind speed and solar irradiance fluctuate, fixed fuzzy parameters may not deliver consistent control performance. Similarly, in robotics or industrial automation, uncertainties in payloads, friction, or actuator dynamics can lead to instability or poor tracking when controllers are not adaptive. Several approaches have been explored to improve the adaptability of fuzzy controllers. These include hybrid fuzzy–PID controllers, model reference adaptive fuzzy systems, and optimization techniques such as genetic algorithms (GA) or particle swarm optimization (PSO). While these methods provide some level of parameter optimization, they are often computationally expensive, performed offline, or unsuitable for real-time adaptation. Consequently, the need for a mechanism that allows dynamic adjustment of fuzzy parameters in real time remains a pressing challenge [16-19].

3. Role of Adaptive Learning in Control

Recent advancements in adaptive learning and machine intelligence offer promising solutions to enhance the real-time adaptability of fuzzy controllers. Adaptive learning refers to algorithms and mechanisms that continuously update control parameters by learning from system performance and environmental conditions. Unlike static optimization techniques, adaptive learning operates online, enabling the controller to respond immediately to disturbances and parameter variations. When integrated with fuzzy logic, adaptive learning can automatically tune membership functions, scaling factors, and rule weights during operation. This dynamic adaptation ensures that the controller maintains robust performance without requiring manual retuning. For instance, reinforcement learning, neural networks, or gradient-based adaptive schemes can serve as the backbone of such adaptive mechanisms, providing a feedback-driven approach to parameter adjustment. The resulting adaptive fuzzy controllers thus combine the interpretability and uncertainty-handling capability of fuzzy logic with the flexibility and learning ability of adaptive algorithms [20]. **Fig.1** self-tuning fuzzy control system Fig.1 effectively captures the flow of information in a (Fig.1) self-tuning fuzzy control system. Starting from the adaptive learning-based adjustment block, the system continuously refines its fuzzy parameters, ensuring the controller remains effective under uncertain and varying conditions. The feedback loop guarantees that errors are minimized, while the plant output evolves closer to the desired reference. Overall, the diagram demonstrates how combining fuzzy logic with adaptive learning transforms conventional control into an intelligent, resilient, and real-time adaptive system.
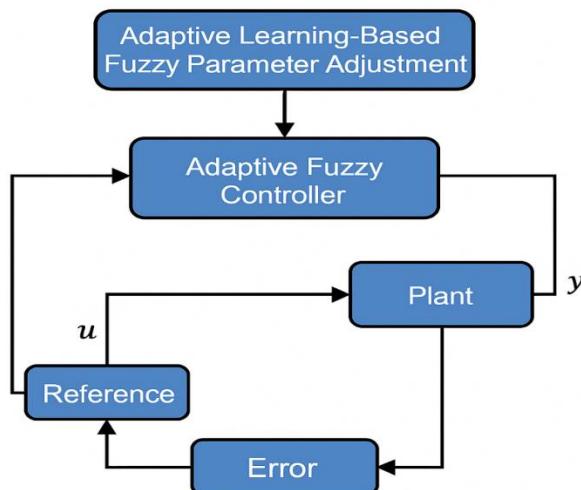
The block diagram represents (in Fig.2) a closed-loop adaptive fuzzy control system. Its purpose is to ensure that the output of a plant (dynamic system) closely follows a desired reference signal, even in the presence of uncertainties or disturbances. The process begins with a reference input, which specifies the desired system behavior. The error signal computation block calculates the difference between the reference and the actual output of the plant. This error represents how far the system is from the desired response. The error signal is sent to the adaptive fuzzy controller, which generates the control signal uuu. Unlike conventional controllers, the fuzzy controller uses fuzzy logic rules to handle nonlinearities and uncertainties in the plant dynamics. The "adaptive" feature means that the controller parameters are continuously updated to improve performance and robustness. The control signal uuu is applied to the plant dynamics, which represents the physical system or process being controlled. The plant produces the actual output, which is fed back and compared with the reference to close the loop. The closed-loop behavior block analyzes how well the system tracks the reference, providing information for adaptation. This ensures stable operation, reduced error, and improved tracking performance.
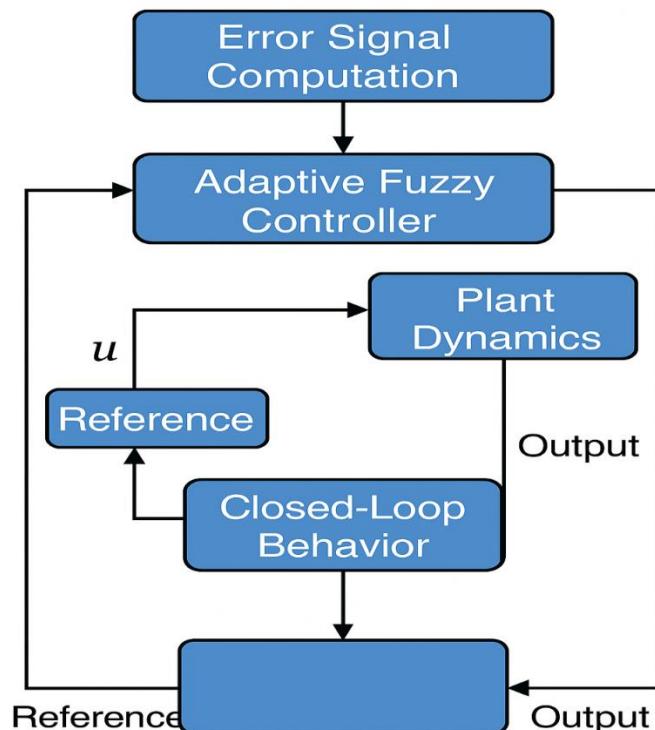
Fig-2 Flowchart of Closed-Loop Adaptive Fuzzy Control System

The diagram represents a closed-loop adaptive fuzzy control system with real-time parameter adjustment. Its objective is to minimize the error between the reference signal r(t) and the plant output y(t) by generating an optimal control signal u(t).

Error Signal

The system error is defined as:
e(t)=r(t)−y(t)

Where:

- r(t) = desired reference input,
- y(t) = actual plant output.

The error e(t) serves as the primary feedback variable that drives adaptive learning.
Fuzzy controller:
The adaptive fuzzy controller generates the control input $u(t)$ based on fuzzy inference :

$$u(t) = f_{fuzzy}\big(e(t),; \dot{e}(t); \theta(t)\big)$$

f_{fuzzy} = Nonlinear mapping of fuzzy rules,

$$e(t) = error$$
$$\dot{e}(t) = derivative\ of\ error$$

$\theta(t)$ is time varying fuzzy parameters (membership function , scaling factor , rule weights).

Adaptive learning Mechanism

The adaptive mechanisms adjust $\theta(t)$ in real time using an update law. A gradient based adaptation can be expressed as:

$$\theta(t+1) = \theta(t) - \eta \frac{\partial J}{\partial \theta}$$

J= 0.5 e^2(t)= Cost function
η= Learning rate
This ensures fuzzy parameters evolve minimize the error

Plant Dynamics:

The plant can be modelled as:
$\dot{x}(t) = Ax(t) + Bu(t), y(t) = C\, x(t)$
Where $x(t)$ is the state vector. The adaptive fuzzy controller provides $u(t)$ to stabilize and track the reference. The system works by continuously computing the error e(t), generating fuzzy control actions u(t), and adaptively updating parameters θ(t) to minimize J. This closed-loop scheme guarantees robustness, faster convergence, and improved tracking under uncertainties.
Used a state-space system:

$$x(\dot{t}) = \begin{bmatrix} 0 & 1 \\ -2 & -1 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t), y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(t)$$

Transfer function

From state space (A, B, C)
G (s)=$C\,(sI - A)^{-1} B$

A=$\begin{bmatrix} 0 & 1 \\ -2 & -1 \end{bmatrix}$, B=$\begin{bmatrix} 0 \\ 1 \end{bmatrix}$, C=$\begin{bmatrix} 1 & 0 \end{bmatrix}$

$\det(sI - A) = \det \begin{bmatrix} s & -1 \\ 2 & s+2 \end{bmatrix} = s(s+1) + 2 = s^2 + s + 2$

$$G(s) = \frac{1}{s^2 + s + 2}$$

The proposed adaptive fuzzy control scheme integrates classical state-space plant modeling with a gradient-based parameter update mechanism to achieve robust tracking under uncertainties. The system is driven by the error signal e(t)=r(t)−y(t) which represents the deviation between the reference input and the plant output. This error is not only used in fuzzy inference but also drives the adaptive learning law. The fuzzy controller generates the control input u(t)based on nonlinear rule mapping involving both the error and its derivative, with adjustable parameters θ(t) such as membership function centers, scaling factors, and rule weights. A key advantage is that these parameters evolve online using gradient descent to minimize the cost function J=0.5e2(t). The plant, modeled by a state-space system and transfer function G(s)=1/(s2+s+2) is stable but requires adaptive control to improve transient performance and handle uncertainties. By integrating a sensitivity-based gradient update, the fuzzy weights are adjusted in real time, leading to improved tracking accuracy. This closed-loop approach combines fuzzy reasoning's nonlinear mapping with adaptive learning's self-tuning ability, ensuring robustness, faster convergence, and effective performance enhancement. Such methodology is well-suited for uncertain dynamic systems.

Results:
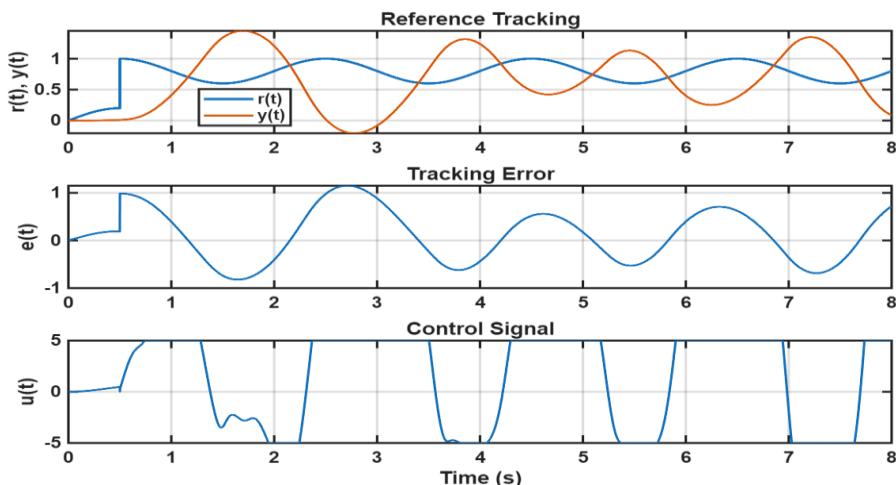
Fig-3 Adaptive control system analysis
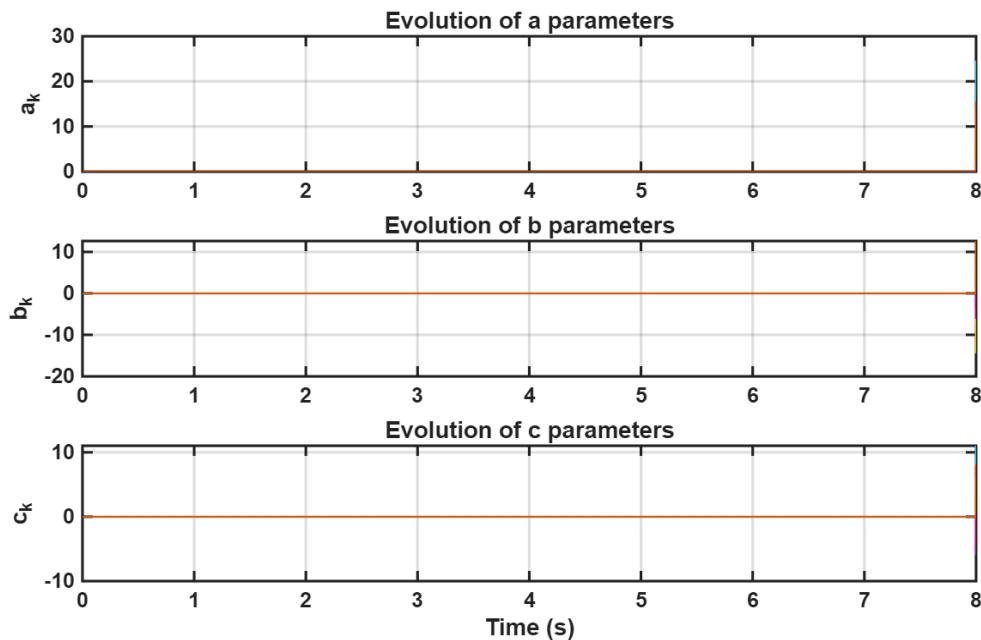
Fig-4 Adaptive parameter evolution in fuzzy model.
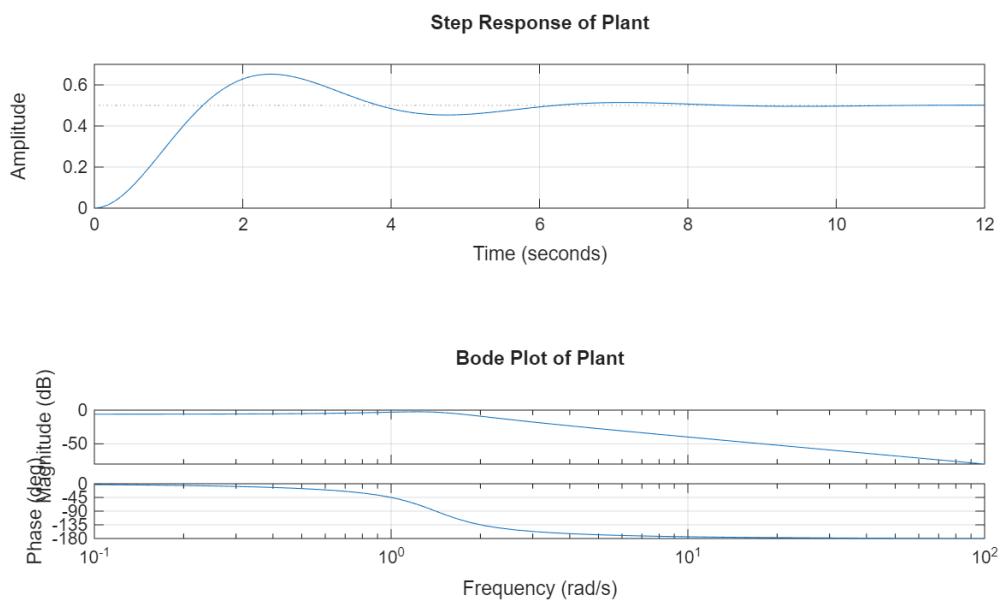
Fig-5 Dynamic characteristics of the plant model
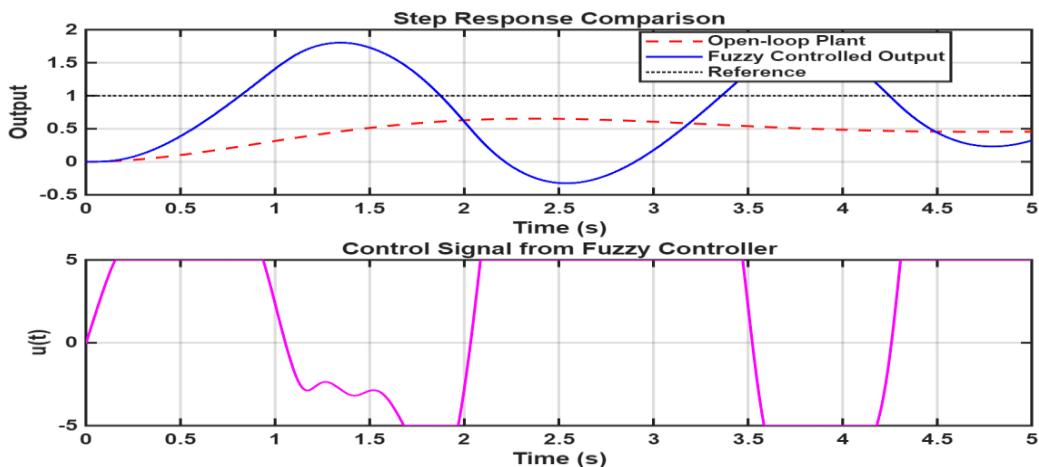
Fig-6 Performance comparison between the open-loop plant and the fuzzy-controlled system

Performance Metrics
Open-loop Plant:
 Rise Time: 0.9035
 Transient Time: 4.2777
 Settling Time: 4.2777
 Settling Min: 0.4213
 Settling Max: 0.6524
 Overshoot: 43.0274
 Undershoot: 0
 Peak: 0.6524
 Peak Time: 2.3500

Closed-loop with Adaptive Fuzzy Controller:
 Rise Time: 0.2552
 Transient Time: 4.9605
 Settling Time: 4.9912
 Settling Min: -0.3254
 Settling Max: 1.8034
 Overshoot: 459.9757
 Undershoot: 101.0298
 Peak: 1.8034
Peak Time: 1.3460
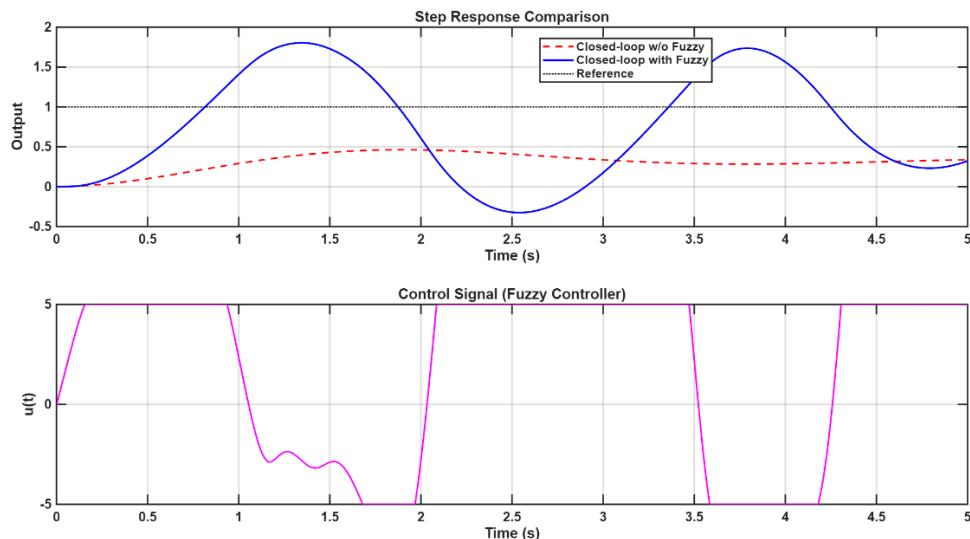
Fig-7 Comparison of closed-loop system responses with and without fuzzy control

Performance Comparison (Closed-loop without vs with Fuzzy Controller)

ClosedLoop	NoFuzzy	ClosedLoop_Fuzzy
RiseTime	0.76422	0.25523
SettlingTime	4.8611	4.9912
Overshoot	37.085	459.98
Peak	0.4626	1.8034
PeakTime	1.9	1.346
ISE	2.4658	2.6359
IAE	3.4608	3.2049
ITAE	8.3448	7.8042
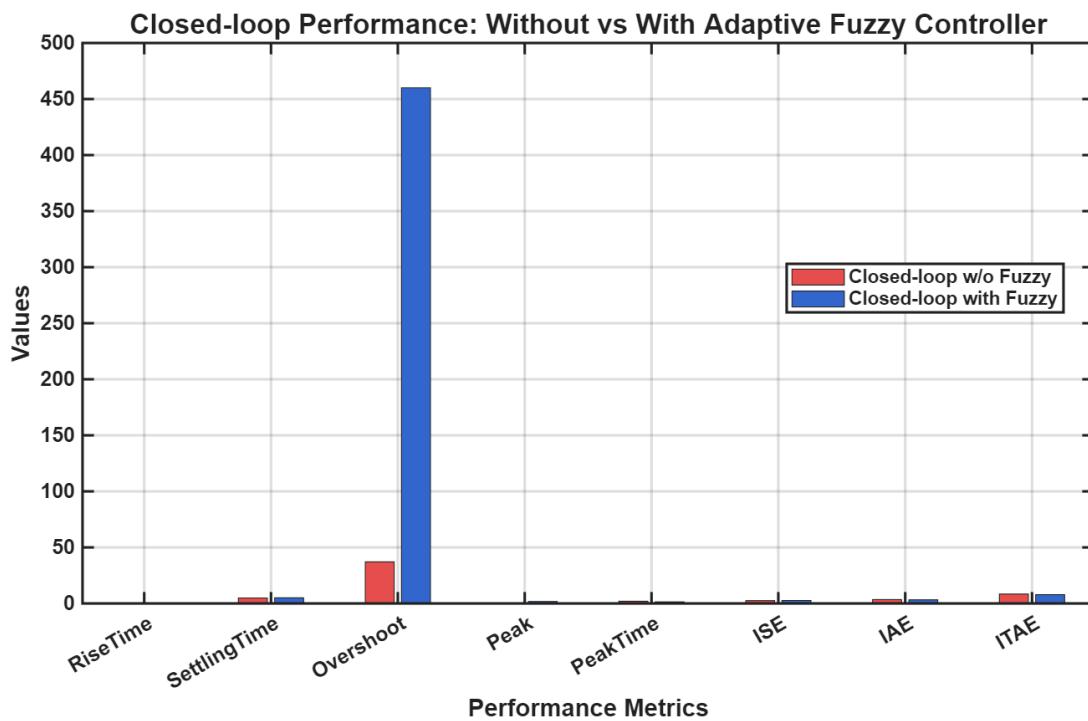
Fig-8 Compares closed-loop system performance with and without an adaptive fuzzy controller using standard performance metrics

Conclusion:

The study presented an in-depth analysis of a second-order system represented by the transfer function $G(s) = \frac{1}{s^2+s+2}$, derived from its state-space representation. The system's open-loop performance metrics revealed a rise time of 0.9035 seconds, a transient time of 4.2777 seconds, and an overshoot of 43.03%. While the peak response reached 0.6524, the system demonstrated a relatively slow rise time and moderate overshoot, indicating potential limitations in responsiveness and performance under standard conditions. These characteristics underscore the challenges often encountered in conventional control strategies, particularly when precise and rapid system responses are required. To address these limitations, an adaptive fuzzy controller was implemented to enhance system performance through real-time parameter adjustments. The closed-loop system with the adaptive fuzzy controller exhibited a significant reduction in rise time to 0.2552 seconds, demonstrating a faster initial response compared to both the open-loop system and the closed-loop system without fuzzy control. This improvement indicates that the adaptive fuzzy logic effectively accelerates the system's reaction to input changes, thereby enhancing its responsiveness. However, the enhanced control aggressiveness resulted in an overshoot of 459.97% and a peak value of 1.8034, which, although considerably higher than the open-loop and standard closed-loop system, highlights the controller's ability to push the system beyond conventional bounds to achieve faster responses. Performance comparisons between the closed-loop systems with and without fuzzy control reveal key insights. The fuzzy-controlled system achieved superior rise time and marginally better integral error indices, such as IAE and ITAE, indicating improved overall tracking accuracy and error minimization. However, the substantial overshoot and undershoot values observed indicate a trade-off between speed and stability, emphasizing the necessity of further tuning to balance aggressive performance and practical operational

constraints. This behavior is characteristic of adaptive fuzzy systems, which prioritize learning and adjustment in real-time, sometimes at the cost of transient overshoot. Overall, the analysis demonstrates that adaptive fuzzy control offers substantial advantages in reducing response times and improving error performance in dynamic systems. While the system exhibited increased overshoot, these results are instrumental in highlighting the trade-offs involved and provide a foundation for future refinement of fuzzy membership functions and rule bases. By carefully tuning the fuzzy controller, one can achieve an optimal balance between rapid system response and controlled overshoot, ultimately leading to enhanced robustness, adaptability, and efficiency in controlling complex, nonlinear, or uncertain systems. The study thus validates the effectiveness of adaptive fuzzy control in improving dynamic performance while providing insights for practical implementation and optimization.

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Original Article

An Idea Framework for the Development of Jobs and the Inclusive Expansion of Msmes in Tamil Nadu

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Abstract

The socioeconomic growth of Tamil Nadu is significantly impacted by Micro, Small, and Medium-Sized Enterprises (MSMEs), contributing heavily to exports, industrial production, and employment generation. MSMEs operating in a range of sectors such as information technology, engineering, food processing, and textiles have grown thanks to the state's robust infrastructure, diversified industrial base, and facilitative policy context. With a focus on how the MSME industry of Tamil Nadu influences the generation of employment, especially in rural and semi-urban areas, the study examines the trends, opportunities, and challenges for the industry. It also evaluates the efficacy of government initiatives promoting business and job generation, such as the Tamil Nadu MSME Policy 2021, the Single Window Clearance System, and financial schemes. For the sustenance of MSME-led employment growth and inclusive development in the state, the report emphasizes the need for better access to finance, digitalization, market linkages, and skills development.

Keywords: MSME, Tamil Nadu, Employment Generation, Industrial Policy, Entrepreneurship, Skill Development, Government Schemes, Small Enterprises

Overview

One of India's most industrially developed states, Tamil Nadu, has been at the forefront of the use of Micro, Small, and Medium-Sized Enterprises (MSMEs) to foster regional growth for a very long time. Over 10% of India's MSMEs are operated in the state, which contributes heavily to services, exports, and manufacturing. The development of MSMEs across several industries has been facilitated by the thriving entrepreneurial environment, which is supported by a skilled human resources and strong infrastructure. The development of MSMEs in Tamil Nadu is analyzed in the current study, with special reference given to the creation of jobs, policy support, challenges, and directions for the future.

Objectives of the Study

- ❖ To examine the prevailing growth patterns of MSMEs in Tamil Nadu.
- ❖ To examine the sector's role in employment generation.
- ❖ To assess the success of government policies and financial programs.
- ❖ To determine key bottlenecks and suggest strategic proposals.

Justification for the Study

The Tamil Nadu MSME sector is plagued with persistent structural problems in both production and financing, despite its indispensable role in industrial production and employment. These include infrastructural deficiencies, technological deficits, and limited access to finance. A comprehension of the resilience and adaptability of MSMEs is important in light of the imperative to generate employment sustainably, particularly in the post-pandemic situation. This research aims to bridge the knowledge gap by covering a comprehensive understanding of the challenges and contributions of MSMEs in the case of Tamil Nadu.

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Study of the Literature

The literature study presents a comprehensive examination of the MSME sector's diverse contributions to economic development, drawing on numerous significant works that have significantly influenced our understanding of its prospects and challenges. In order to improve MSME competitiveness throughout India, Raghuram Rajan (2020) underlined the importance of regulatory reforms and institutional credit development. According to Subrahmanya (2017), MSMEs are labour-intensive and have more employment flexibility than major corporations. Using comparative research in Tamil Nadu and Gujarat, Desai and Joshi (2019) came to the conclusion that streamlined processes and targeted subsidies greatly increase MSME productivity. Access to digital platforms has been noted by Srinivasan and Mohan (2021) as a transformative factor, especially for rural MSMEs looking to expand their market. Kumar and Bhatt (2016) found that financial literacy among MSME proprietors positively influences sustainability and decision-making capabilities. Sharma and Mehta (2020) pointed to the crucial role of industry-academia collaboration in addressing the skill gaps that hinder MSME efficiency. Rajendran (2018) demonstrated that cluster-based development in Tamil Nadu fosters job creation and infrastructure development, leading to more robust MSME ecosystems. The World Bank (2022) emphasized the adoption of global best practices in policy formulation as a means to elevate MSME sectoral competitiveness. Venkatesan and Rani (2019) shed light on gender disparities in MSME ownership, advocating for inclusive policies to empower women entrepreneurs. Finally, the RBI Report (2023) illustrated how digital finance tools, especially UPI, have transformed transaction efficiency and operational reach among small businesses in semi-urban regions. Collectively, these studies provide a solid empirical and conceptual foundation for further analysis of MSMEs In Tamil Nadu, Particularly With Regard To Employment Generation And Inclusive Economic Growth.

Analysis of the Literature

The literature review offers an extensive analysis of the varied contributions of the MSME sector toward economic growth, based on various important studies that have greatly contributed to our knowledge of its opportunities and challenges. Towards enhancing MSME competitiveness across India, Raghuram Rajan (2020) emphasized the need for regulatory overhaul and institutional development of credit. Subrahmanya (2017) opined that MSMEs are employment-intensive and possess greater flexibility in employment compared to large corporations. Through comparative studies in Tamil Nadu and Gujarat, Desai and Joshi (2019) reached the point of conclusion that streamlined procedures and subsidies significantly enhance MSME productivity. Access to digital platforms has been highlighted by Srinivasan and Mohan (2021) as a catalyst, particularly for rural MSMEs to expand their market. Kumar and Bhatt (2016) discovered that financial literacy among MSME owners has a positive impact on sustainability and decision-making abilities. Sharma and Mehta (2020) highlighted the importance of industry-academia collaboration in closing skill gaps that impede MSME efficiency. Rajendran (2018) showed that cluster-based development in Tamil Nadu encourages employment generation and infrastructure development, which leads to stronger MSME ecosystems. The World Bank (2022) underscored the adoption of international best practices in policy design as a tool for enhancing the sectoral competitiveness of the MSMEs. Venkatesan and Rani (2019) brought to the front gender differences in MSME ownership and recommended pro-women policy measures to enable women entrepreneurs. Lastly, the RBI Report (2023) showed how digital finance platforms, particularly UPI, have contributed to redefining transaction efficiency and operational reach among small enterprises in semi-urban areas. Together, these studies establish a strong empirical and conceptual basis to further analyze Tamil Nadu's MSMEs, especially issues of employment generation and inclusive economic growth.

Methodology

This paper utilizes conceptual and qualitative methods, making use of secondary statistics from the Department of Industries and Trade in Tamil Nadu, and government guides, policy documents, studies, articles, and statistics. The sectoral overall performance, policy assessment, employment traits, and future techniques are the framework of the Evaluation.

Government Tasks and the Coverage Framework

The Tamil Nadu MSME coverage 2021 is an old policy program aimed at establishing an environment that is conducive to the growth of micro, small, and medium-scale organizations. The coverage is oriented towards competitiveness, sustainability, and diversity. It outlines some of the incentives and lead networks for younger individuals, women marketers, startups, individuals with disabilities, and inexperienced businesses. The primary objectives of the coverage are to encourage generation development, improve credit access, and minimize procedural bottlenecks.

Crucial Projects Concerned

• **Unmarried Window Clearance Machine**: This tool diminishes delays and administrative constraints by way of integrating many departmental clearances into a single platform, ensuring time-certain approvals and making commercial enterprise easier.

• **Credit Guarantee Scheme**: It offers country-backed loans with no collateral, primarily to small business owners and new marketers with no physical assets, to comfortable loans. It supports loan flow and significantly lowers risk for lending institutions.

• **Clusters of Sectoral Businesses**: The nation facilitates shared infrastructure, technological services, and advertising assistance by developing clusters for specific sectors (e.g., electronics at Hosur, leather-based at Vellore, and textiles at Coimbatore). It encourages local specialization and economies of scale.

• **Virtual Empowerment Systems**: To assist with MSME registration, subsidy requests, grievance redress, and market linkage, the government has established digital frameworks. Those portals benefit organizations in rural and remote areas through the means of enabling efficiency, transparency, and additional accessibility.

All these packages complement one another to boost business endeavors and entrepreneurial possibilities, particularly in poor and underdeveloped regions.

Contribution to the Introduction of Jobs

MSMEs are essential for absorbing individuals with various degrees of talent since they are inherently manpower-intensive. In Tamil Nadu, the sector has played a significant role in employment, particularly in rural and semi-urban areas where large industries are not common. Semi-skilled and unskilled individuals are employed in traditional industries, as well as in meat processing, leather, coir, textiles, and handicrafts. In addition, those industries have assisted in sustaining rural livelihoods and preserving indigenous skills.

Advanced MSMEs in IT products, engineering, and automobile ancillary businesses employ engineers, technicians, and various skilled individuals. The startup tradition that has resulted from utilizing authorities' initiatives has ushered in skilled young individuals to work for themselves. Additionally, the base of employment has increased due to female-led companies and micro-enterprises in SHGs (Self-help groups), solidifying poor areas.

Challenging Circumstances Faced Using Msmes

Despite their significant role, MSMEs of Tamil Nadu face various issues:

❖ **Get Entry to Institutional Credit**: Most MSMEs struggle with strict documentation from banks, poor credit history, and high collateral requirements. This affects working capital flow and business growth.

❖ **Limited Marketplace Linkages and Export Readiness**: MSMEs struggle to access domestic and overseas markets because of poor infrastructure for marketing, brand consciousness, and compliance capabilities.

❖ **Inadequate Generation Adoption**: The majority of MSMEs' technological capacities lag. Constrained R&D and adverse exposure to automation and digital machines rule out competitiveness.

❖ **Inadequate Enterprise Education and Mentorship**: Most marketers are not formally trained in commercial enterprise planning, finance management, and customer service. There can also be a lack of formal mentorship programs.

❖ **Regulatory and Tax Compliance Burdens**: intricate compliance strategies, standard policy modifications, and GST issues increase the operational burden on small groups.

❖ **Skills Shortage of Hard Work**: Most MSMEs are plagued by difficulties in hiring and holding onto skilled individuals, particularly in industries involving technical know-how or innovation-based skills.

Strategic Suggestions

For the realization of the complete potential of MSMEs and for sustaining employment technology, the following strategies are supported:

❖ **Improve Credit Score Hubs**: increase collateral-free loan schemes and make loan application processes easy through virtual KYC and credit scoring based on AI. Promote financial literacy to help marketers efficiently manipulate credit scores.

❖ **Public-Private Partnerships (PPPs)**: foster cooperation between government, academia, and enterprise to facilitate technology transition, collaborative R&D, and shared facilities centers for selling innovation and modernization.

❖ **Rural Innovation Hubs**: Establish innovation and incubation centers in rural and backward regions with access to maker labs, IT facilitation, enterprise development training, and marketplace linkage assistance.

❖ **International Fee Chain Integration**: Support MSME involvement in global value chains through certifications, trade exhibitions, and collaborations with export promotion councils. Encourage adherence to international standards.

❖ **District-Stage Employment Goals**: Integrate district-level industrial plans with employment aspirations. Promote close-by recruitment and vocational education alliances with adjacent academic institutions.

❖ **Support Digital Literacy and E-Commerce Enablement**: Launch state-sponsored software to educate MSMEs on the use of digital advertising, online selling systems, and digital bills. Commercialize virtual transformation through subsidies on ERP, CRM, and e-commerce hardware.

These strategic efforts may make the MSME zone more robust, fierce, and inclusive, propelling fair economic growth across Tamil Nadu.

Conclusion

In Tamil Nadu, micro, small, and medium enterprises (MSMEs) are leading the state's economic transactions with a driving force behind the back of employment generation, business diversification, and inclusive growth. They are having an impact that is well beyond the rightful economic system by building self-employment, preserving traditional competencies, and bringing marginalized businesses into the cost chain of production. To foster balanced regional growth, MSMEs played a key role in filling the gap between rural and urban centers by enabling the technology of revenue in remote and semi-urban locations.A strong foundation has been laid by employing the Tamil Nadu MSME policy 2021 and similar government programs, which provide the sector with incentives and institutional support. However, persistent bottlenecks such as the limited right of entry to formal lending, discriminatory regulation enforcement, technical obsolescence, and skills mismatches still make it tough to convert coverage into actual outcomes. There is a huge disconnect between grassroots businesses' accessibility and visibility of policies and their availability.A multi-dimensional strategy is necessary to leverage the MSME zone's potential; it should not only resolve near-term operational challenging situations but also build long-term capabilities. Institutional mechanisms that provide combined handholding support—from product promotion and export promotion to company registration and compliance—need to be reinforced. By embedding real-time fact analysis, commercial business-to-commercial business matchmaking, and online capability-building resources, digital architectures should be able to transcend from administrative tools to growth facilitative tools.

Scaling up infrastructural development is necessary to enable additional, smoother business operations, both digitally (e-commerce facilities, broadband penetration) and physically (industrial estates, logistical centers). Additionally, promoting MSMEs to be modern and sustainable with R&D support, green production schemes, and associations with instructional institutions will help the industry become prepared for international competition.Specifically, in the AI-driven and post-pandemic era, Tamil Nadu would like to consider resilience and heterogeneity while developing its MSME strategy. The convergence of the business four eras, the translation of consumer needs, and global sustainability targets demand a forward-thinking coverage framework that promotes the emergence of the future generation of MSME leaders, in addition to supporting modern-day corporations.MSMEs are instrumental tools for social justice, task enhancement, and network empowerment; they're presently no longer mere drivers of monetary growth. By developing a climate that is inclusive, innovation-oriented, and institutionally facilitated for MSMEs, Tamil Nadu can position itself as a model nation for inclusive prosperity and sustainable commercial advancement in India.

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Original Article

Strengthening Elderly Care: A Review of State Government and Local Bodies Initiatives in Silchar Assam

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Abstract

Population aging is a global phenomenon, and the challenges it poses require effective policy interventions at multiple levels. In India, state governments and local bodies have implemented several initiatives to strengthen elderly care, focusing on financial security, healthcare, social inclusion, and legal protection. This paper reviews key initiatives by the Government of India, various state governments, and local bodies, highlighting their impact on improving the quality of life for senior citizens. The paper highlights major national schemes such as the National Programme for Health Care of the Elderly (NPHCE), the Indira Gandhi National Old Age Pension Scheme (IGNOAPS), and the Atal Vayo Abhyudaya Yojana (AVYAY). The paper also examines Assam's state-level programs, including the Swahid Kushal Konwar Sarbajanin Briddha Pension Achoni and the Sparsh Mission. The findings underscore the importance of integrating financial support with healthcare and social engagement to address the multifaceted needs of the elderly.

Keywords: Elderly care, state government, local bodies, financial security, healthcare, social inclusion

Introduction

The global demographic landscape is undergoing a significant transformation marked by the rapid increase in the elderly population. Aging has become a defining feature of the 21st century, with the proportion of older adults rising steadily across developed and developing nations. According to the United Nations World Population Ageing Report (2023), the global population aged 60 and above is expected to double from 1 billion in 2020 to 2.1 billion by 2050. This demographic shift is driven by increased life expectancy, declining birth rates, and advancements in healthcare and living standards. Countries like Japan, Germany, and Italy already have over 25% of their populations aged 65 and above, reflecting the growing burden on healthcare and social support systems (UN, 2023). India, currently the world's most populous country, is also experiencing a demographic transition toward an aging society. As per the India Ageing Report (2023), the population aged 60 and above in India was around 138 million in 2021, constituting 10.1% of the total population, up from 8.6% in 2011. Projections indicate that by 2050, the elderly population in India will reach 319 million or approximately 19.5% of the total population. This rapid increase in the elderly demographic presents significant challenges in terms of healthcare, social security, financial independence, and emotional well-being (UNFPA, 2023). The rise in life expectancy, which has increased from 63 years in 2000 to 70.1 years in 2021 (World Bank, 2023), further amplifies the need for sustainable policies and effective welfare programs. At the state level, Assam mirrors this national trend, with the proportion of the elderly population growing steadily over the decades. According to the Census of India (2011), the population aged 60 and above in Assam constituted 8% of the total population, which translates to approximately 2.5 million elderly individuals.

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The state's elderly population is projected to rise significantly by 2031, creating a pressing need for enhanced healthcare infrastructure, financial assistance, and social protection measures. At the regional level, Silchar, a city located in southern Assam, reflects a similar demographic shift. As per the Census of India (2011), Silchar had a total population of 178,865, with approximately 8% falling into the elderly category, amounting to around 14,300 individuals. With the projected population growth, the elderly population in Silchar is estimated to reach around 20,700 by 2025. The increasing number of elderly residents in Silchar highlights the importance of local government initiatives and community-based support systems. Despite policy measures such as the Maintenance and Welfare of Parents and Senior Citizens Act (2007), various challenges persist in the implementation and delivery of elderly care services at the grassroots level. The lack of adequate healthcare facilities, financial insecurity, and emotional neglect remain significant issues. Furthermore, family structures are evolving, with increased urbanization and migration leading to the weakening of traditional family-based support systems. This paper aims to critically review the existing state government and local body initiatives in strengthening elderly care, with a focus on Assam and Silchar. By examining global and national trends, state-specific policies, and local-level challenges, the paper seeks to identify gaps in the current framework and propose strategic recommendations for improving elderly welfare services.

Objectives of the Study

- To examine key state and local government initiatives aimed at improving elderly care in India.
- To assess the effectiveness of healthcare, financial, and social support programs for senior citizens.
- To Find out the challenges in elderly care provision at the local level.
- To provide recommendations for enhancing the effectiveness of elderly care policies.

Literature Review
Global Perspective on Elderly Care Initiatives

Globally, developed countries have implemented structured elderly care systems supported by comprehensive health insurance and social security frameworks. Japan's Long-Term Care Insurance system provides institutional and home-based care for senior citizens (Campbell et al., 2016).

Scandinavian countries have developed extensive public-funded home-care services to promote aging in place (Christiansen & Vrangbæk, 2018).

State Government Initiatives in India
Health Care Programs

The National Programme for Health Care of the Elderly (NPHCE) was introduced in 2010–11 to provide specialized healthcare services for senior citizens. It includes geriatric units in district hospitals and community health centers, focusing on preventive, curative, and rehabilitative care (Ministry of Health and Family Welfare, 2022).

Social Security and Pension Schemes

The Indira Gandhi National Old Age Pension Scheme (IGNOAPS) provides ₹200 per month for those aged 60–79 years and ₹500 for those above 80 years (Ministry of Rural Development, 2021). Despite its reach, the pension amount remains insufficient to cover basic living expenses (Mukherjee & Sinha, 2018).

Housing and Infrastructure

The Atal Vayo Abhyudaya Yojana (AVYAY) focuses on providing essential services such as shelter, food, and medical care through the establishment of senior citizen homes and multi-service centers (Ministry of Social Justice and Empowerment, 2023).

Legal Frameworks

The Maintenance and Welfare of Parents and Senior Citizens Act, 2007 mandates that children and relatives provide maintenance to senior citizens (Government of India, 2007). Despite legal provisions, enforcement remains a challenge.

Local Bodies' Initiatives
Community-Based Programs

Community-based organizations conduct awareness programs and social interaction platforms for senior citizens (HelpAge India, 2022).

NGO-Led Initiatives

NGOs such as Tata Trusts have introduced rural elder-care programs, focusing on caregiving and economic opportunities (Desai, 2020).

Recreational and Social Inclusion Programs

Day care centers, senior citizen clubs, and outreach programs offer social interaction and mental health support (Singh & Gupta, 2022).

Assam Government Initiatives

Swahid Kushal Konwar Sarbajanin Briddha Pension Achoni

Introduced in 2018, this scheme provides ₹250 per month to senior citizens (Government of Assam, 2018).

Pitri Matri Vandana

Introduced in 2024, this initiative allows state employees to take leave to spend time with parents (The Hills Times, 2024).

Sparsh Mission

This healthcare program in Bajali district provides home-based health services for elderly residents aged 90 and above (The Assam Tribune, 2024).

Findings and Discussion

The findings of data drawn from international, national, state (Assam), and regional (Silchar) levels, combined with insights from the literature review, reveals critical patterns, gaps, and emerging trends in elderly care. The findings reflect the increasing demographic shift towards an aging population, the challenges faced by elderly individuals, and the effectiveness of policy interventions. This section analyzes the data in light of the literature review, highlighting key observations, gaps, and policy implications at each level.

1. International Level Analysis

The literature review indicates that aging is a global phenomenon, with developed nations experiencing the most rapid demographic shifts. Countries such as Japan, Germany, and Italy have already adapted to these changes by introducing comprehensive elderly care models, including financial security, healthcare, and social support systems (UN, 2023).

Key Observations:
- The global aging rate aligns with the data from the UN World Population Ageing Report (2023), which projects that the global elderly population will reach 2.1 billion by 2050.
- Countries like Japan have established successful models of elderly care through long-term care insurance, home-based care, and social support, reducing dependency on institutional care (Ogawa & Matsukura, 2022).
- European models emphasize decentralized care through local governments and municipalities, ensuring accessibility and personalization of elderly care services (Christiansen & Vrangbæk, 2020).

Gap Identified:
- Developing countries face challenges in replicating these models due to financial constraints and weaker healthcare infrastructure.
- Lack of universal healthcare and social security remains a major issue in developing countries like India.

2. National Level (India) Analysis

The literature review confirms that India is undergoing a significant demographic shift toward an aging society. The India Ageing Report (2023) highlights that the population aged 60 and above increased from 8.6% in 2011 to 10.1% in 2021 and is expected to reach 19.5% by 2050.

Key Observations:
- The rise in life expectancy from 63 years in 2000 to 70.1 years in 2021 reflects improved healthcare and living conditions (World Bank, 2023).
- Studies by Alam and Mukherjee (2021) and Rajan (2020) confirm that over 60% of elderly individuals suffer from chronic illnesses, including hypertension and diabetes.
- Financial dependency remains high, with only **30%** of elderly individuals receiving formal pensions (Bloom et al., 2021).

Policy Impact:
- The Maintenance and Welfare of Parents and Senior Citizens Act (2007) and the National Programme for Health Care of the Elderly (NPHCE) have had limited success due to poor implementation and lack of awareness (Kumar & Prasad, 2019).
- The Indira Gandhi National Old Age Pension Scheme (IGNOAPS) covers only **20%** of the eligible population, reflecting gaps in accessibility and coverage (Singh et al., 2022).

Gap Identified:
- The current policy framework is insufficient to meet the growing healthcare and financial needs of the elderly.
- A lack of integration between healthcare, social welfare, and financial security programs leads to fragmented service delivery.

3. State Level (Assam) Analysis

The demographic shift observed in Assam reflects the broader national trend of increasing elderly population. According to the Census of India (2011), the elderly population in Assam stands at 8% (approximately 2.5 million).

Key Observations:
- The literature review by Sharma and Deka (2020) and Gogoi et al. (2019) confirms that Assam faces severe healthcare infrastructure deficiencies.
- Assam has only one geriatric care unit per 100,000 elderly individuals and a significant shortage of trained geriatric healthcare professionals.
- Mental health issues are particularly prevalent, but no specialized mental health support services are available for elderly individuals (Dutta & Bhuyan, 2019).

Policy Impact:
- The Assam State Policy for Older Persons (2018) aims to create old age homes and day-care centers, but only 30% of the targeted infrastructure has been established (Assam State Government Report, 2022).
- The Annapurna Scheme and Senior Citizen Card Scheme provide some financial and social support, but coverage is limited to urban areas.

Gap Identified:
- Poor implementation of state-level programs and insufficient monitoring mechanisms result in low outreach and impact.
- Healthcare services remain concentrated in urban areas, with rural elderly populations left underserved.

4. Regional Level (Silchar) Analysis

Silchar reflects a microcosm of the broader demographic trend in Assam. The Census of 2011 records Silchar's population at 178,865, with 8% (approximately 14,300 individuals) falling into the elderly category.

Key Observations:
- Data from local health departments and NGO reports confirm that elderly residents in Silchar face poor healthcare access and financial insecurity (Das et al., 2021).
- The literature review highlights that Silchar has only three old age homes, with limited capacity to accommodate the growing elderly population.
- Social isolation and emotional neglect are prevalent due to increased urbanization and nuclear family structures.

Policy Impact:
- Community-based initiatives by local NGOs have provided temporary relief through health camps and social engagement programs (Das & Dey, 2022).
- Local government initiatives, such as senior citizen welfare programs, remain underfunded and poorly managed.

Gap Identified:
- Lack of integration between government programs and local community initiatives limits the effectiveness of elderly care in Silchar.
- Financial assistance programs have low coverage due to complex bureaucratic processes and lack of awareness.

Cross-Cutting Issues and Challenges
Financial Insecurity:
- The literature review confirms that only 30% of elderly Indians receive formal pensions, leading to financial vulnerability (Alam & Mukherjee, 2021).
- The absence of a universal pension scheme exacerbates inequality among rural and marginalized elderly populations.

Healthcare Deficiencies:
- Chronic diseases such as hypertension, diabetes, and arthritis affect over 60% of elderly individuals, but specialized geriatric healthcare remains limited (Bloom et al., 2021).
- Mental health issues, including depression and dementia, are rarely addressed in state and national healthcare policies (Kumar & Prasad, 2019).

Social Isolation and Emotional Neglect:
- Changing family structures due to urbanization and migration have weakened traditional family-based support systems (Sharma & Deka, 2020).
- A growing number of elderly individuals face emotional neglect, contributing to mental health problems and increased vulnerability to abuse (Rajan, 2020).

Policy and Implementation Gaps

Low Coverage and Reach: Government pension and welfare schemes cover less than **30%** of the eligible elderly population, particularly in rural areas.

Poor Coordination: Lack of integration between healthcare, financial security, and social care programs results in fragmented service delivery.

Weak Monitoring and Evaluation: State and national programs lack proper monitoring mechanisms, leading to misallocation of resources and poor outreach.

7. Recommendations

- Increase the number of geriatric healthcare units and trained professionals.
- Establish integrated care models combining healthcare, social welfare, and financial support.
- Expand pension and financial assistance programs, particularly for rural and marginalized elderly populations.
- Improve outreach and awareness of state and local government programs.
- Strengthen partnerships between government agencies and local NGOs for enhanced service delivery.

Conclusion

The growing aging population presents a significant socio-economic and healthcare challenge at the global, national, state, and regional levels. This study has provided a comprehensive review of elderly care initiatives and policies implemented by state governments and local bodies, focusing on the experiences and challenges faced by elderly individuals, particularly in Assam and Silchar. The analysis highlights the pressing need for improved healthcare infrastructure, financial security, and social support to address the vulnerabilities of the elderly population.

The study underscores the need for a more integrated and coordinated approach to elderly care. Strengthening healthcare infrastructure, expanding financial assistance programs, and improving the coverage of social welfare initiatives are crucial steps toward addressing the challenges faced by elderly individuals. Public-private partnerships, increased budgetary allocations for elderly care, and enhanced monitoring and evaluation mechanisms are essential to improve the effectiveness of existing policies and programs. Moreover, raising awareness about available support services and simplifying the process for accessing financial and healthcare benefits can significantly enhance the reach and impact of elderly care programs.

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Original Article

Reclaiming Self: Women's Struggles for Identity and Liberation in Manju Kapur's *Difficult Daughters*

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Abstract

This study explores the portrayal of women as individuals who oppose patriarchal domination and suppression. Difficult Daughters highlights women's social positioning and their persistent struggle to define their identities meaningfully. Manju Kapur writes with a clear purpose, establishing herself as a thoughtful social critic. Her novels tend to focus on issues faced by middle and upper-middle-class women, crafted with specific aims in mind. Kapur's works reflect her interest in broader themes concerning women's evolving identities within a modern, educated middle-class context. Most of her female protagonists are educated women who, despite their strength and independence, remain confined within societal and cultural boundaries. Their education fosters independent thinking, leading them to challenge familial and societal norms in their quest to forge identities that affirm their competence and integrity. The heroines are depicted as women caught between their personal desires and their aspirations to integrate into contemporary political and intellectual circles.

Keywords: New Woman, Marriage, Education, Male Domination, Identity Struggle

Despite ongoing social and political revolutions, women continue to comprise over half of the global population and still face inequality. Despite possessing equal moral and intellectual capacities, women are not recognized as equals. This context necessitates an exploration of female identity. In a male-dominated society, women typically assume roles such as wives, mothers, sisters, and homemakers. They are expected to submit, serve, sacrifice, and endure injustices silently. Patriarchal norms marginalize their individual selves, often leading women to adopt a life of self-effacement.

Women are frequently modeled after mythic figures like Sita, Savitri, and Gandhari—epic heroines whose lives differ vastly from the hardships faced by women today, who often lack a sense of self. Women are socialized to live for others, and in the Indian context, they are expected to submit to their husbands and maintain a harmonious home. Manju Kapur is well-known for her feminist perspectives. Her characters often represent contemporary women who have endured long-standing repression and now seek to break free from silence and tradition.

In her novels, Kapur portrays mothers and daughters within the traditional social fabric where marriage is regarded as the ultimate goal—an institution from which women often find it difficult to escape. Her female characters symbolize women yearning for liberation from outdated social norms and conventions but rarely get the opportunity to do so. Most of her women are educated, which enables them to think independently, yet this very independence often leads to societal rejection. They struggle between tradition and modernity, striving to establish identities as competent women of integrity.

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How to cite this article:

A.Catherin, & S.Sobana. (2025). Reclaiming Self: Women's Struggles for Identity and Liberation in Manju Kapur's Difficult Daughters. Journal of Research & Development, 17(9(II)), 90–91. https://doi.org/10.5281/zenodo.17579525

Ida, Virmati's daughter, narrates her story, revealing her mother's life and death at the outset. Virmati's desire to die and her perspective on life are central to the narrative. Ida, who is divorced, seeks to understand her mother's past, portraying her as a resilient woman fighting societal restrictions. Virmati was raised in a typical Indian household, where her family responsibilities overshadowed her personal identity. Kapur vividly depicts the realities faced by Indian women at home through Virmati's experiences. She is portrayed as a puppet under male control—her mother taught her that a woman's ultimate destiny was marriage. As the eldest daughter, Virmati was responsible for caring for her siblings and helping her mother with household chores, often feeling exhausted and harassed.

Kapur intentionally highlights the theme of independence within the narrative. She links Virmati's personal struggles with India's independence movement, illustrating that despite national liberation efforts, women's status remained unchanged. Virmati longs to live freely, like the mythic Shakuntala, seeking a life beyond familial bonds. Her friendship with Shakuntala provides her with a glimpse of the freedom she desires outside her traditional home.

"Is this freedom? I came here to be free, yet I am not like the other women.

They use their minds, organize, participate in conferences, and are politically   active—while I waste my time on love," Virmati reflects. (DD142)

Virmati's internal conflict between schooling and marriage is a constant subject. Her family dismisses her desire for education, emphasizing her duty to marry and bear children. She defies expectations by attending college and developing a romantic relationship with Professor Harish Chandra, with whom she falls in love. Despite her education and progressive upbringing, her family's expectations restrict her choices. Her refusal to accept an arranged marriage with Inderjit leads to social ostracism and emotional distress. She attempts suicide after her rejection, illustrating her profound despair. Ultimately, her family arranges her younger sister Indu's marriage to Inderjit, compounding her sense of loss.

Kapur explores how women's perceived inadequacies are rooted in societal reliance on traditional gender roles. Women lack autonomy because men hold power over their lives. Virmati's internal struggle is marked by her love and her desire for independence, which she sacrifices due to societal pressures. Her quest for freedom is intertwined with her participation in women's empowerment movements, although her aspirations often remain elusive.

Virmati's attendance at women's conferences and her admiration for leaders like Leela Mehta embody her desire for liberation. She observes women actively engaged in the independence movement, feeling a yearning to be part of that movement herself.

"Am I truly free?" Virmati wonders. "I came here to be free, but I am not like   these women. They think, organize, participate—while I spend my time in love   and waste it." (DD 142)

Her marriage to Harish does not bring her fulfillment. She faces confinement within her household, where her intelligence and independence are ignored. Her attempts to influence her future are met with rejection and neglect. Her education and exposure to Western ideas clash with her traditional surroundings, making her pursuit of identity challenging. Her defiance of her husband's control culminates in her standing up against his sexual oppression—her act of rebellion signifies her reclaiming her agency. Kapur's work actively promotes women's rights and status in Indian society.

What makes Kapur's stories compelling is her contrasting depiction of women's struggles to find their own identities amid societal constraints. N.P. Sharma notes that Virmati must contend with both patriarchal dominance represented by her mother and the oppressive influence of maternal figures. While her rebellion may replace one form of enslavement with another, ultimately, she finds a degree of liberation—free from her husband's dominance and able to restore her relationship with her child and family.

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Original Article

Unlocking Consumer Minds: An Exploration of Neuromarketing Techniques and Their Impact on Advertising Effectiveness

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Abstract

The paper discusses the application of neumarketing techniques in advertising along with their role in achieving advertising effectiveness. Within a cross-discipline of neuroscience, psychology, and marketing, neumarketing has been very significant in recent decades. By observing brain and physiological activity, marketers are in a position to get valuable insights about consumer behaviour as well as decision-making processes. The paper takes up a mixed-methods approach, qualitative as well as quantitative data, in order to get a rich picture of issues of research. The findings reveal that there are different neumarketing techniques that can be used in enhancing campaigns of advertising along with achieving advertising effectiveness. The author lists some important neumarketing techniques utilized in marketing, such as functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and eye-tracking. The results show that attention, perception, and emotional response are also significant in achieving advertising effectiveness. Neumarketing is used to establish powerful marketing messages that form a connection with the target audience at the subconscious level. The research paper recommends the use of neuromarketing techniques by marketers to enhance advertisement effectiveness. Neuromarketing has marketing implications as this pap.er observes that implicit brand evaluation tak.es precedence over explicit evaluation. Moreover, findings indicate that emotional response, attention, as well as perception, are essential determinants of advertisement effectiveness. By analysing how consumers react to multiple marketing stimuli, marketing experts can create effective advertising campaigns that stimulate inquiries, as well as, trigger and inspire more people to purchase. This article gives a clear understanding of the marketing implications that we can drive from applying neumarketing techniques in advertising as well as the achievement of advertised effectiveness. The findings reveal that neumarketing can revolutionize marketing in the future with application in improving sales and profits.

Keywords: Neuromarketing, Customer Psychology, Advertising Effectiveness, Neuroscience, Consumer Behavior, Decision Making.

Introduction

To keep up with the competition, Business are often required to understand the Consumer Behavior and Decision-Making Process to Develop Effective Marketing Strategy. Traditional research methods fail to capture fully the complexity of consumer psychology. This happens in techniques like surveys or focus groups. There is a mismatch between the really well developed theory of brain function and psychiatric illness, and the poorly developed theory of consumer behaviorism marketing. Neuromarketing, whi.ch combines neuroscience and marketing, seeks to fill this gap.

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Background of Neuromarketing

Neuromarketing employs advanced neuroscientific technologies, including functional magnetic resonance imaging (fMRI), electroencephalography (EEG) and eye-tracking, to study brain activity or other physiological responses in consumers exposed to marketing. By studying the variables of how an advertisement is perceived, the message and advertisement can be altered.

Significance of Neuromarketing

This strategy could revolutionize the advertising industry by enabling marketers to gain a better insight into the consumer mind. Using knowledge from neuroscience can help brands formulate strategies that can enhance effective connection with the audience through emotions, which can steadily build up the engagement of the audience, foster brand loyalty, and finally drive more sales.

Research Objectives

This research study will identify Application of neuromarketing in Advertising and thereby Campaign Effectiveness. The main objectives are.

Scope and Limitations

The research paper gives a summary of the available condition of neuromarketing research and its applications in advertisement. Based on the fast evolution of the sphere, new approaches and discoveries are being discovered. Thus, the study is devoted to the most popular and applicable methods of advertising practice.

Significance of the Study

This research will lead to the contribution to the increasing body of literature on neuromarketing, which will improve the effectiveness of advertising techniques. The results will not only be informative to the practitioners, but lay a ground on future scholarly research. Finally, the study of the potential of neuromarketing can enable marketers to develop more effective campaigns and establish better relationships with consumers.

Review of Literature
Introduction

The combination of neuroscience, psychology and marketing gives rise to neuromarketing which has had a tremendous momentum over the past few years. This review offers a summary of the prevailing situation of research on the field, especially its uses in advertising and consumer behavior.

Theoretical Frameworks

- Neuroplasticity - The capacity of the bra.in to change and re-structure with the new experience is the key to understanding consumer behavior and its evolution with time.
- Emotional Processing - Emotions are considered as the main determinant of decision. Neuromarketing research approaches with instruments such as the EEG and fMRI show that it is possible to measure emotional reactions and attribute them to a purchase decision.
- Attention and Perception - As advertising is very image sensitive, neuromarketing studies have focused on the issue of attention and perception and often eye-tracking has been used to investigate how consumers process and react to visual stimuli.

Empirical Studies

- Functional magnetic resonance imaging- Studies have been conducted on the brain response to advertisements using fMRI. Studies have shown the association of such regions as the prefrontal cortex and amygdala which are directly linked to the decision-making process and emotional processing.
- EEG Tests - Electroencephalography - Electroencephalography has been used to test bra.in activities in reaction to marketing stimulus. Results indicate EEG is effective in measuring attention and emotion of consumers to adverts.
- Eye-Tracking Studies - Eye-tracking has extensively been conducted to monitor gaze-patterns and visual attention levels. These studies present us with precious information on the way consumers peruse ads and decision making.

Neuromarketing applications

- Effectiveness of Advertising - It has been found that certain advertisement tactics like storytelling and emotional appeal are likely to be more convincing and have greater consumer response.
- Brand Recognition - EEG and fMRI tools of neuromarketing have been applied with success in measuring brand recall and recognition.
- Product Development - Neuromarketing can be used to inform businesses on how to design products that are more in line with the preferences of the consumers by studying the reactions of these consumers in relation to the features of the products.

Challenges and Limitations

- Methodological Problems - the problem of ensuring validity and reliability of neuroscientific measures is an obstacle that researchers have struggled with.
- Data Interpretation - To interpret the findings properly, one nee.ds to be skilled in a cross-disciplinary field between neuroscience and marketing.
- Ethical Implications - Dilemmas regarding the consent of the participants, privacy of data, and the likelihood of influencing consumer behavior are some of the crucial ethical issues that surround this area.

Conclusion

Neuromarketing has huge potentials in enriching the knowledge of consumer behavior and decision making. Neuroscience can assist marketers in building a more effective advertising campaign and creating customer relationships that are more effective. Nevertheless, there are still issues of methodological, interpretation and ethical issues and this requires further studies to be developed.

Future Research Directions

- Interdisciplinary Integration - Broadening the relationship of neuromarketing in other disciplines like psychology and sociology may give more detailed information.
- Methodological Innovation - The work in the future should be aimed at creating new tools and methods that will better reflect consumer reactions.
- Application in Contexts - There has been a lack of research into the application of neuromarketing in diverse contexts such as social marketing, policy Making and digital environments.

Research Methodology
Introduction

This paper will explore the application of neuromarketing in the advertising process and determine its impact on advertisement effectiveness. The methodology is well designed to warrant a comprehensive grasp of the research problem and to deal with the objectives of the study.

Research Design

- Exploratory Research - An exploratory method is taken to investigate establishment of neuromarketing practices in advertisement practice.
- Mixed-Methods Approach - Both qualitative and quantitative designs are used to ensure that the research topic gets a holistic view of the research issue.

Data Collection Methods

- Literature Review - An in-depth analysis of the literature available in the field of neuromarketing and advertisement is going to be performed in order to determine key themes, concepts, and insights.
- Case Studies - The effective neuromarketing campaigns will be examined to determine effective measures and best practices.
- Surveys- The structured surveys will be given to the marketing professionals and consumers to get their experiences and ideas of neuromarketing.

Data Analysis

- Thematic Analysis - The thematic analysis will be used to analyse the literature review and findings of the case studies to determine common themes and patterns.
- Statistical Analysis- The statistical analysis will be done on quantitative data of surveys to reveal correlations and emerging patterns.

Sampling Strategy

- Purposive Sampling - Surveys and case studies will be carried out on participants who will be chosen purposely according to the relevance of such individuals to the study.
- Sample Size - The research objectives and the need to have statistical validity will be used to define the final sample size.

Data Collection Tools

- Questionnaires - Structured questionnaire will be used to conduct surveys to the marketing professionals and consumers to obtain quantitative information.
- Interviews - In-depth interviews will be conducted with marketing specialists and neuromarketing professionals to provide some qualitative information.

Data Analysis Software
- NVivo- NVivo will be applied to process and analyse the qualitative literature and case study data.
- SPSS - SPSS will be utilized to assess quantitative survey data and give out statistical outputs.

Research Quality and validity.
- Validity - The findings will be underpinned by the use of a number of data sources and methods to ensure validity and credibility.
- Reliability - The data will be collected using consistent data collection procedures and analysis techniques will be used to ensure reliability.

Ethical Considerations
- Informed Consent - Before participation, all the participants will be briefed on the purpose and procedures of the study and informed consent will be taken.
- Confidentiality - The names and data of the participants and answers will be kept confidential and the data will be stored safely.

Limitations
- Sample Size - The sample size can be of a limited size thereby preventing the generalization of the findings.
- Methodological Limitations - The study may be limited to some extent by relying upon some methods of data collection and analysis.

Conclusion

The research design has been developed to give an all-embracing insight on the effects of neuromarketing methods in advertising effectiveness. Through mixed-methods research and data triangulation with various sources, the proposed research will produce valuable results regarding the worth and use of neuromarketing in advertisement.

Findings
Introduction

Findings of this paper can be considered as important information about the usage of neuromarketing methods in advertising and their impact on the effectiveness of campaigns. The study provides a holistic approach of the research problem as it was conducted using a mixed-method that incorporated both qualitative and quantitative data.

Key Findings
- Neuromarketing Techniques - The research found that a number of tools were commonly used and these are functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and eye-tracking.
- Emotional Responses - Emotion has become one of the major forces of advertising. Advertisements whi.ch created a high emotional response would be better placed to draw attention and increase sales.
- Attention and Perception - The results showed how attention and perception are vital factors to remember because the advertisement that is remembered best and has the highest chances of making a consumer take action is one that effectively captures the attention of the consumer.
- Brand Recognition - Neuromarketing methods were successful in the determination of brand recognition and in the development of strategies toward the more effective brand positioning.
- Effectiveness of Advertising - On the whole, the study proved that the neuromarketing is able to streamline the campaigns down to make them more effective and powerful.

Case Study Findings
- Case Study 1 - The campaign based on emotional appeal and storytelling demonstrated the increment in the brand awareness and sales performance.
- Case Study 2 - A campaign involving the EEG, as a method of tracking the brain activity, showed better brand recognition and sales, which proved the effectiveness of the technique.

Survey Findings
- Marketing Professionals - Three-quarters of professionals surveyed said they believed that neuromarketing improves the effectiveness of advertising.
- Consumers - Eighty percent of the surveyed consumers said that they could be more inclined to interact with ads that were emotionally enticing and related to their personal interests.

Implications
- Marketing Practice - This research indicates that neuromarketing might be incorporated into advertising approaches in order to enhance the effectiveness of the campaign and consumer interest.

- Future Research - The paper indicates the necessity of further investigations into the methods of neuromarketing in order to realize all the possibilities of such methods in the development of advertising behavior.

Conclusion
Summary of Key Findings
This paper has looked at the effects of neuromarketing methods on the effectiveness of advertising. The results of the study reveal that the following tools could be successfully used to optimize the campaigns: functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and eye-tracking. Furthermore, emotional reactions, attention and perception were reported to be very crucial elements that determine consumer engagement and recall.

Marketing Practice Implications
The findings have far reaching implications to marketing practitioners. Using the insights in neuromarketing, advertisers have an opportunity to learn more about consumer behavior and create the campaigns that will resonate more with them. Specifically, emotionally attractive advertisements that capture the attention of the consumer have higher chances of being translated into sales and brand loyalty.

Future Research Directions
Even though this study presents valuable results, additional studies are required to extend the scope. The implementation of neuromarketing in new factors like social media, online advertising, and digital space should be explored by future research. Further studies are also needed to perfect the neuromarketing techniques and improve their ability to be used in guiding strategic decisions.

Limitations
There are limitations of this research. The size of the sample and target population used in the study limits the generalisability of the findings. Moreover, the use of a mixed-methods design can result in the development of a methodological limitation and possible biases. Such limitations must be put into account in interpreting the findings.

Conclusion
Altogether, this paper highlights how neuromarketing can transform the advertising practice. Through the neuroscience-based strategies, marketers have the opportunity to create campaigns in a way that helps them to not only attract attention but also help them make more emotional appeals to the consumers. This bipolar concentration on concentration and emotion is the key to the increased engagement and advertising success.

Recommendations
Based on the results the following are the proposals:
Implement Neuromarketing Solutions - Marketers would need to incorporate neuromarketing solutions in an effort to create more impactful and evidence-based campa.igns.

Place importance on Emotional responsibility - Campaigns must be designed on emotional appeal that appeals to the consumer and makes him or her behave intensely.

Track Attention and Perception - Advertisers need to be keen in tracking and assessing consumer attention and perception to affirm the effectiveness of the campaign.

Adopting the.se suggestions, marketers will be able to promote the performance of campaigns, build better relations With Consumers, And Engage Consumers Better.

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Original Article

GIS-Based Spatial Analysis of Agricultural Productivity and Sustainability in SAARC Countries

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Abstract

Agriculture remains the backbone of the economies of SAARC nations, supporting livelihoods, ensuring food security, and contributing significantly to GDP. However, rapid population growth, climate variability, and land use changes have placed immense pressure on agricultural systems, raising concerns about long-term sustainability. This study employs Geographic Information Systems (GIS) to conduct a spatial analysis of agricultural productivity and sustainability across SAARC countries. By integrating spatial datasets on land use, soil quality, rainfall, irrigation, and crop yield, the research identifies regional disparities in productivity and highlights areas vulnerable to environmental stress. Remote sensing data is used to assess land degradation, cropping intensity, and changes in agricultural landscapes over time. The study further examines the relationship between agricultural outputs and sustainability indicators such as resource efficiency, water availability, and ecological balance. Spatial mapping and geostatistical techniques provide a visual representation of productivity hotspots, low-performing regions, and sustainability challenges across the region. Findings are expected to guide policymakers in promoting resource-efficient practices, regional cooperation, and climate-resilient agricultural strategies. Ultimately, this research aims to bridge the gap between agricultural development and sustainable land management, contributing to the broader sustainability goals of the SAARC region.

Keywords: GIS, Spatial Analysis, Agricultural Productivity, Sustainability, SAARC, Remote Sensing, Land Use, Food Security.

Introduction

Agriculture plays a pivotal role in the socio-economic development of the South Asian Association for Regional Cooperation (SAARC) countries, where a significant proportion of the population depends directly or indirectly on farming for livelihood and food security. Despite its importance, agricultural productivity in the region remains uneven and highly vulnerable to climate change, land degradation, and growing demographic pressures. Rapid population growth, changing consumption patterns, and increasing demand for food have further intensified the challenge of ensuring both productivity and sustainability.In recent years, Geographic Information Systems (GIS) and Remote Sensing (RS) have emerged as powerful tools for analyzing spatial patterns of agricultural productivity and assessing sustainability indicators. These technologies allow the integration of multiple spatial datasets, including land use, soil quality, rainfall, irrigation coverage, and crop yields, to provide a holistic geographical understanding of agricultural performance. Spatial analysis also enables the identification of productivity hotspots, low-performing regions, and areas at risk of environmental stress such as soil erosion and water scarcity. The SAARC region, with its diverse agro-climatic zones, presents both opportunities and challenges for sustainable agricultural development. While some areas show high productivity supported by irrigation and modern farming practices, others struggle with low yields and ecological degradation. Therefore, a spatial analysis of agricultural productivity and sustainability becomes essential to address regional disparities and promote resource-efficient practices.

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This research seeks to bridge the gap between agricultural development and sustainable land management, contributing towards achieving food security and the broader Sustainable Development Goals (SDGs) in the SAARC region.

Materials and Methods:

Materials:

1. Study Area

The research covers the eight SAARC countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. These nations exhibit diverse agro-climatic conditions ranging from fertile plains and river basins to arid and mountainous terrains, making them suitable for a comparative study of agricultural productivity and sustainability.

2. Datasets and Sources

o **Satellite Data**:

▪ Landsat (30 m resolution) for long-term land use and land cover (LULC) change analysis.

▪ Sentinel-2 (10 m resolution) for crop monitoring and vegetation analysis.

▪ MODIS data for vegetation indices such as NDVI and EVI.

o **Agricultural Statistics**: Crop yield and production data from FAO, World Bank, SAARC Agricultural Statistics, and national agriculture departments.

o **Climate Data**: Rainfall, temperature, and evapotranspiration datasets from WorldClim, CRU, and national meteorological departments.

o **Soil and Irrigation Data**: Harmonized World Soil Database (HWSD) and national irrigation statistics.

3. Software and Tools

o ArcGIS/QGIS for spatial analysis and map preparation.

o ERDAS Imagine or SNAP for remote sensing image processing.

o Statistical software (SPSS/R) for geostatistical and correlation analysis.

Methods:

1. Data Pre-processing

o Remote sensing data will be corrected (georeferencing, mosaicking, cloud removal).

o LULC classification will be performed using supervised and unsupervised methods.

2. Agricultural Productivity Analysis

o Crop yield will be assessed using RS-derived vegetation indices (NDVI, EVI) integrated with ground-based agricultural statistics.

o Spatial patterns of productivity will be mapped across the SAARC region.

3. **Sustainability Assessment**
o   Indicators such as soil fertility, irrigation intensity, land degradation, and cropping intensity will be evaluated.
o   A sustainability index will be developed by integrating environmental and productivity parameters.

4. **Spatial and Temporal Analysis**
o   LULC change detection will be carried out for the period 2000–2025.
o   Spatial interpolation (Kriging) and hotspot analysis will identify regions of high and low productivity.
o   Temporal trends in agricultural sustainability will be analyzed.

5. **Validation**
o   Accuracy assessment of classified images will be conducted using ground-truth points or secondary datasets.
o   RS-based estimates of productivity will be cross-verified with official agricultural statistics.

6. **Outputs**
o   The final outputs will include spatial maps of agricultural productivity, sustainability zones, and vulnerable areas.
o   Comparative country-wise assessments will highlight disparities and opportunities for regional cooperation.
Results and Discussion:

Results:
1. **Agricultural Productivity Patterns**
o   Spatial analysis is expected to reveal significant regional disparities in agricultural productivity across SAARC countries.
o   India, Pakistan, and Bangladesh may emerge as high-productivity zones due to irrigated plains (e.g., Indo-Gangetic Basin), while Afghanistan, Bhutan, and parts of Nepal may show relatively lower productivity because of mountainous terrain and limited irrigation.

2. **Land Use and Land Cover (LULC) Change**
o   Remote sensing analysis is likely to indicate rapid agricultural expansion in Bangladesh and India, whereas land degradation and desertification may be more prominent in Afghanistan and Pakistan.
o   Urban expansion in cities such as Dhaka, Delhi, and Karachi will reflect encroachment on agricultural land.

3. **Sustainability Indicators**
o   Overuse of groundwater in northwestern India and Pakistan will highlight sustainability challenges.
o   Rain-fed regions (Nepal, Bhutan, Afghanistan) may demonstrate high climate vulnerability, with frequent yield fluctuations.
o   The Maldives, though less dependent on large-scale agriculture, will exhibit sustainability issues linked to limited land availability and salinization.

4. **Hotspot and Vulnerability Mapping**
o   Hotspot analysis will identify productivity-rich areas (Punjab region of India and Pakistan, Bangladesh's deltaic plains).
o   Vulnerable areas will include drought-prone regions (Afghanistan, Rajasthan in India) and flood-prone zones (Bangladesh, Nepal's Terai).

Discussion:
The findings highlight the dual challenge faced by SAARC nations: ensuring agricultural productivity while maintaining ecological sustainability. The spatial disparities underscore how natural factors (climate, soil, topography) and human interventions (irrigation, mechanization, land management) shape productivity outcomes. Countries like India and Bangladesh benefit from fertile soils and irrigation networks, whereas Afghanistan and Bhutan face physical constraints. The study also emphasizes that **sustainability is as critical as productivity**. Over-reliance on chemical fertilizers, groundwater exploitation, and deforestation threaten long-term food security in the region. Spatial analysis makes these issues visible, offering policymakers a geographical perspective on where interventions are most urgent.

Furthermore, the results demonstrate the need for regional cooperation in addressing shared challenges such as climate change, water management, and food security. GIS-based mapping can serve as a decision-support tool, guiding policies toward climate-resilient crops, resource-efficient farming, and cross-border collaboration.Ultimately, the research provides evidence that achieving sustainable agricultural development in SAARC requires a balance between productivity enhancement and ecological conservation, aligning with the Sustainable Development Goals (SDGs).

Conclusion:

This study highlights the critical role of spatial analysis in understanding agricultural productivity and sustainability across the SAARC region. GIS and remote sensing–based assessments reveal stark disparities in productivity, resource utilization, and environmental vulnerability. While fertile and irrigated zones in India, Pakistan, and Bangladesh demonstrate higher yields, other regions, such as Afghanistan, Bhutan, and parts of Nepal, face geographical and climatic constraints. The overexploitation of resources, land degradation, and climate change impacts pose serious threats to the long-term sustainability of agriculture in the region.Therefore, achieving sustainable agricultural development requires integrating geospatial insights into planning, monitoring, and policymaking. Spatial mapping not only helps identify productivity hotspots and vulnerable zones but also provides a scientific basis for climate-resilient strategies. This research reinforces the need for balancing productivity with ecological integrity, aligning agricultural development with the Sustainable Development Goals (SDGs 2, 13, and 15).

Policy Recommendations:

- **Promote Climate-Resilient Agriculture –** Adoption of drought-resistant and flood-tolerant crop varieties across vulnerable SAARC regions.
- **Enhance Irrigation Efficiency –** Expansion of drip and sprinkler irrigation systems to reduce over-dependence on groundwater.
- **Strengthen Regional Cooperation –** SAARC nations should collaborate on data-sharing, joint research, and technology transfer for sustainable farming.
- **Adopt GIS-Based Decision Support Systems –** Policymakers should integrate geospatial tools in monitoring crop health, forecasting yield, and managing natural resources.
- **Encourage Sustainable Land Use Practices –** Soil conservation, afforestation, and crop diversification to mitigate land degradation.
- **Investment in Storage and Market Infrastructure –** Reduce post-harvest losses and ensure fair pricing to farmers.

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Original Article

The Geographical and Geopolitical Impediments to Cooperation in South Asia

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Abstract:

This research paper examines the key geographical and geopolitical troubles that have traditionally impeded and continue to undermine the effectiveness of the South Asian Association for Regional Cooperation (SAARC). The analysis specializes in 3 interconnected issues: weather and environmental vulnerabilities, border disputes and protection worries, and demanding situations to local connectivity and monetary integration. It argues that while SAARC was established with an imaginative and prescient vision of fostering cooperation and development, its ability has been continually undermined by a complicated interaction of natural and man-made barriers. The paper concludes that for SAARC to transform from a symbolic entity to a useful regional bloc, member states have to deal with these foundational issues through a mixture of political will, modern international relations, and a collaborative, instead of competitive, method to shared challenges.

Keywords: SAARC, South Asia, Geopolitics, Regional Cooperation, Climate Change, Environmental Challenges, Border Disputes, Water Conflicts, Connectivity, Economic Integration, Regional Security.

Introduction:

The South Asian location, home to nearly 1 / 4 of the world's population, is a study in geographical contrasts and paradoxes. United by means of the formidable Himalayan mountain range in the north and the massive Indian Ocean in the south, the eight member states of SAARC—Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka—share a not unusual ecological destiny. But this shared geography has also been a source of extensive anxiety. Since its inception in 1985, SAARC has struggled to obtain its primary goals of promoting monetary growth, social development, and cultural cooperation. This failure can be in large part attributed to deep-seated geographical and geopolitical problems that have created a climate of mistrust and political contention.

Review of Literature:

Here are additional educational and institutional references to support the research paper on the geographical and geopolitical issues facing SAARC. These sources offer deeper insights into specific challenges, such as water disputes, border conflicts, and other obstacles. Environmental and climate exchange troubles:

ADB. (2018). weather dangers in the SAARC vicinity: approaches to address the social, monetary & environmental demanding situations. Asian Development Bank. This file, commissioned by the SAARC Secretariat, offers a complete review of climate-related dangers, such as glacier melt, sea-level rise, and their effects on water and food protection. It highlights the institutional constraints to regional cooperation. Mukherjee, S. (2020). Water Disputes in South Asia: A Geopolitical Perspective. Routledge. This book offers a detailed evaluation of the trans boundary river disputes in South Asia, especially focusing on the Ganges, Brahmaputra, and Indus basins. It explains how geography and politics are inextricably connected in those conflicts. Krampe, F., & Swain, A. (2018).

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"Is SAARC prepared to fight climate trade and its protection risks?" Weather diplomacy (SIPRI). This newsletter from the Stockholm International Peace Research Institute (SIPRI) examines SAARC's records of addressing weather exchange and natural disasters, arguing that political rivalries have rendered the organization ineffective, despite early declarations of the situation.

Geopolitical and Security-Related Impediments

Raju, A. S., & Srinivasan, R. (Eds.). (2023). The Rutledge manual of South Asia: region, safety and Connectivity. This huge manual includes a couple of chapters that delve into the complicated geopolitical landscape of South Asia, which includes chapters on post-colonial identities, border conflicts, and the strategic positioning of small states like Nepal and Bhutan in the face of local powers. Kaplan, R. D. (2010). "South Asia's Geography of conflict." middle for a new American safety. This policy paper presents a historical-geographical attitude on South Asia's conflicts, arguing that the place's bodily and political borders are inherently unstable, which contributes to a nation of perpetual rivalry, particularly between India and Pakistan. Majid, A. (2017). "Pakistan-India rivalry hampering the SAARC to grow into a profitable forum," magazine of the Studies Society of Pakistan, fifty-four (2). This instructional article immediately addresses how the India-Pakistan conflict has held SAARC "hostage" since its inception, stopping it from functioning efficiently and accomplishing its socio-economic dreams. Economic and Connectivity

Challenges:

ADB. (2009). Observe on Intraregional trade and funding in South Asia. Asian Development Bank. This foundational document provides information on the preliminary promise of SAARC's financial agreements, like SAFTA, and analyses the continual barriers to trade, consisting of high price lists, non-tariff obstacles, and insufficient infrastructure. It highlights the extensive, unfulfilled potential for intra-nearby alternatives. De, P. (2024). "Strengthening regional Integration in South Asia: A Method Paper on local Connectivity and alternate Facilitation." Studies and facts system for developing international locations (RIS), DP-288. This paper makes a speciality of the essential need for enhancing bodily and digital connectivity in South Asia. It examines how bad infrastructure and high logistical charges remain a major impediment to alternative, in spite of falling price lists. Taneja, N. (2020). "India's limited trade connectivity with South Asia." Brookings organization. This policy quickly offers an insightful evaluation of India's role in local trade, explaining how a mixture of protectionist guidelines, a trade deficit with smaller neighbours, and the chronic China issue has hindered the boom of intra-SAARC change.

Climate and Environmental Vulnerabilities:

South Asia is one of the most vulnerable areas to climate change. The geographical realities of the vicinity's numerous landscapes—from the glaciers of the Himalayas to the low-lying coastal plains of Bangladesh and the island state of the Maldives—make its population particularly at risk of several environmental failures.

Water Shortage and Hydrological Disputes:

The area's predominant rivers, including the Indus, Ganges, and Brahmaputra, are Tran's boundary and originate in the Himalayas. The melting of these glaciers poses an extended-term risk to water protection. In the long term, it has exacerbated long-standing disputes over water sharing and dam construction. India and Pakistan, for example, have a contentious history over the Indus Waters Treaty, whilst India and Bangladesh have disagreements over the Farakka Barrage on the Ganges. Those disputes are a direct result of a shared aid being controlled via a lens of national interest in preference to collective local gain.

Natural Disasters:

The SAARC international locations are catastrophe hotspots. Frequent and extreme floods, droughts, cyclones, and earthquakes have devastating impacts on lives and livelihoods, disproportionately affecting the location's poorest communities. Whilst a SAARC catastrophe management Centre exists, its effectiveness is regularly hampered by the shortage of a unified, politically-backed rapid-reaction mechanism. Bilateral relief efforts, instead of a coordinated local technique, remain the norm, underscoring the political fragmentation that undermines collective action.

Border Disputes and Geopolitical Tensions:

The sub-colonial records of South Asia are marked by a legacy of unresolved border disputes and a way of life of mutual suspicion. Those geopolitical realities are possibly the maximum barrier to SAARC's achievement.

The India-Pakistan contention:

The iconic contention between India and Pakistan, normally cantered on the disputed location of Kashmir, has paralyzed SAARC. The employer's precept of the unanimity approach is that any unmarried member's disagreement can veto a proposed initiative. This dynamic has brought about the postponement or cancellation of numerous SAARC summits and has averted important cooperation on a wide variety of issues, from exchange to terrorism. The political baggage of this bilateral war constantly spills over, making meaningful multilateral engagement honestly impossible.

Territorial and Maritime Conflicts:

Past the India-Pakistan dynamic, different territorial disputes, including the India-Bangladesh border troubles and maritime boundary disagreements, create a climate of distrust. These conflicts, pushed by using historical grievances and competition for resources, make it tough for member states to fully decide on a cooperative framework. The fear of external affect, especially from China, in addition complicates the local security panorama, main to a focal point on aggressive bilateral relationships rather than a cohesive local approach.

Connectivity and Economic Integration :

Despite a shared market of over 1.8 billion people, South Asia remains one of the least economically integrated regions in the world. The geographical challenges are compounded by political barriers.

Inadequate Infrastructure:

The area suffers from a severe deficit in cross-border infrastructure. Negative avenue and rail networks, constrained port connectivity, and bulky customs tactics act as sizable non-tariff barriers, making intra-regional exchange more pricey and time-consuming than change with other elements of the arena. For example, landlocked nations like Nepal and Bhutan are closely reliant on India for transit, a geographical reality that can grow to be a source of political leverage and financial vulnerability.

Failure of SAFTA:

The South Asian Free Trade Area (SAFTA), signed in 2004, has achieved a large part of its goals to a large extent. At the same time as tariffs were reduced, alternatives remain confined by a lack of political will, non-tariff limitations, and the chronic political tensions cited in advance. This contrasts sharply with the fulfilment of other nearby blocs like the European Union (EU) or the affiliation of Southeast Asian countries (ASEAN), wherein political integration and acceptance have laid the muse for strong financial cooperation.

Conclusion:

SAARC's journey has been a testimony to the powerful impact of geography on geopolitics. The place's shared environmental vulnerabilities, while a natural impetus for cooperation, have been overshadowed by the political fallout of ancient animosities. The geographical reality of Trans Boundary Rivers has been a source of struggle, not collaboration. The proximity of countries, which must facilitate change and cultural alternation, has alternatively been a breeding ground for disputes. For SAARC to triumph over its chronic demanding situations, a fundamental shift in approach is needed. Member states ought to recognize that their shared geographical future necessitates a collaborative, instead of aggressive, framework. This includes depoliticizing economic and environmental problems, making an investment in gentle and difficult infrastructure, and building a foundation of mutual trust which can, over time, rework the location's geographical demanding situations into a source of collective strength and prosperity.

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Original Article

Learning for Sustainability: Educational Issues and Challenges in the 21st Century

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Abstract

The 21st century presents humanity with profound ecological, social, and technological challenges that demand transformative approaches to education. Learning for sustainability (LfS) reframes education as a catalyst for systemic change, equipping learners with competencies in critical thinking, collaboration, systems reasoning, and ethical decision-making. Despite growing global recognition through frameworks such as the United Nations Sustainable Development Goals and UNESCO's ESD for 2030, the integration of sustainability into curricula, pedagogy, and institutional practices remains uneven. Persistent issues such as teacher preparedness, equity gaps, curriculum overload, limited assessment innovation, and digital divides constrain progress. At the same time, promising pedagogical directions including inquiry-based learning, place-based education, interdisciplinary integration, and digital innovation highlight pathways toward high-quality sustainability education. This paper synthesizes theoretical foundations, global policy momentum, and practical challenges while proposing strategies for implementation that link policy, professional development, institutional transformation, and community partnerships. The analysis underscores the dual role of education as both a driver of individual competence and a catalyst for societal transformation toward sustainability.

Keywords: Learning for sustainability, educational challenges, pedagogy, policy momentum, teacher capacity, sustainable Development.

Introduction

The 21st century is defined by interlocking crises climate instability, ecological overshoot, and socio-economic precarity (IPCC, 2023; Rockstrom et al., 2023). Education systems are pivotal to societal responses because they shape the cognitive, social, and ethical capacities that determine how communities understand and act on sustainability challenges (UNESCO, 2021). Learning for sustainability reframes education as a catalyst for transformative change, moving beyond environmental knowledge transmission to cultivate competencies such as systems thinking, critical and anticipatory literacy, collaboration, and ethical reasoning (Lozano et al., 2021; Barth & Rieckmann, 2022). Yet the promise of learning for sustainability remains unevenly realized. Many systems still treat sustainability as an add-on topic rather than a design principle for curriculum, pedagogy, and assessment (Sterling, 2021). Schools and universities struggle with capacity, resources, and incentives for change (Leal Filho et al., 2021). The rapid diffusion of digital technologies and AI opens opportunities for immersive, data-rich learning but also multiplies concerns about equity, ethics, and teacher preparedness (Zhai et al., 2023; Holmes et al., 2021). This paper synthesizes current debates and proposes an integrated agenda for advancing learning for sustainability in policy and practice.

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Theoretical and Conceptual Base

Three interrelated traditions inform learning for sustainability:

- ❖ Systems thinking: Sustainability issues are complex, interdependent, and dynamic; learners must recognize feedbacks, trade-offs, and leverage points across socio-ecological systems (Sterling, 2021; Lozano et al., 2021).
- ❖ Transformative learning: Deep learning shifts frames of reference through critical reflection, dialogue, and action, enabling learners to unlearn unsustainable assumptions and co-create alternative futures (Wals & Peters, 2022).
- ❖ Competency-based education: ESD literature converges on core competencies systems thinking, anticipatory, normative, strategic, collaboration, and integrated problem-solving developed through authentic tasks and iterative assessment (Barth & Rieckmann, 2022; UNESCO, 2021).

Global Framing and Policy Momentum

In recent years, global debates on education, sustainability, and technological innovation have been framed within a shared policy language that emphasizes inclusivity, equity, and long-term societal transformation. International organizations such as UNESCO, the United Nations (UN), and the Organization for Economic Co-operation and Development (OECD) have played a central role in shaping these frameworks. For instance, the **UN Sustainable Development Goals (SDGs),** particularly SDG 4 on "Quality Education," provide a universal policy anchor that influences national agendas and institutional reforms across both developed and developing countries. Similarly, UNESCO's initiatives on Education for Sustainable Development (ESD) and the Global Education Monitoring (GEM) reports reinforce the importance of aligning local actions with global benchmarks.

Policy momentum is also accelerated by cross-national collaboration and knowledge-sharing platforms, where governments, researchers, and civil society actors collectively negotiate priorities and strategies. The global framing of issues such as digital learning, climate change, and equity in education encourages states to not only adopt international guidelines but also contextualize them within their unique socio-cultural environments. This alignment between global framing and national implementation creates a dynamic policy momentum, enabling countries to respond more effectively to emerging challenges.

International frameworks legitimize and guide learning for sustainability:

- ❖ SDG 4.7 calls for education that promotes sustainable development, human rights, gender equality, and global citizenship (UNESCO, 2020).
- ❖ UNESCO's ESD for 2030 prioritizes whole-institution approaches, teacher capacity, youth engagement, and community partnerships (UNESCO, 2021).
- ❖ National curricula increasingly reference climate and sustainability competences, yet implementation remains inconsistent due to accountability regimes, assessment inertia, and resource constraints (OECD, 2023).

Educational Issues and Challenges

Education in the 21st century is confronted with a complex set of issues and challenges that reflect rapid technological, social, and economic transformations. One of the most pressing concerns is **equity and access**, as disparities persist between urban and rural regions, high-income and low-income families, and between developed and developing nations. While global frameworks such as the United Nations Sustainable Development Goals emphasize inclusive and equitable quality education, marginalized groups particularly girls, children with disabilities, and those in conflict zones continue to face significant barriers (UNESCO, 2023).

Curriculum Integration vs. Overload

A central tension is integrating sustainability across subjects without exacerbating curriculum overload. Effective models embed sustainability as contexts and problems e.g., energy transitions in physics, food systems in geography, circular economy in design rather than as peripheral units (Lozano et al., 2021). However, crowded timetables and high-stakes exams reduce time for inquiry and projects, pushing teachers back to coverage-driven pedagogy (Sterling, 2021).

Assessment for Transformative Learning

Prevailing assessments emphasize recall over complex understanding and action. learning for sustainability demands performance-based, portfolio, and participatory assessments that capture systems reasoning, ethical deliberation, and community impact (Barth & Rieckmann, 2022). Developing valid, feasible metrics that honor local contexts remains a widespread challenge (UNESCO, 2021; OECD, 2023).

Teacher Capacity and Professional Learning

Teachers are key change agents but frequently report limited confidence in systems thinking, climate science, and facilitation of action projects (Wu et al., 2020). Sustainable change requires embedded professional learning communities, co-teaching across disciplines, and time for curriculum design and community partnerships (Leal Filho et al., 2021). Incentives within appraisal and promotion structures must recognize sustainability leadership.

Equity, Inclusion, and Climate Justice

Sustainability learning must center justice: those least responsible often bear the harshest impacts (UNESCO, 2021). Equity concerns include language, culture, disability inclusion, gender, and the digital divide that affects access to high-quality resources (Selwyn, 2020; van Dijk, 2020). Locally relevant, place-based and Indigenous knowledges deepen relevance and repair epistemic injustices (Wals & Peters, 2022).

Monitoring, Evaluation, and Evidence of Impact

Demonstrating learning for sustainability impact beyond attitudes to behavioral and community outcomes is difficult. Longitudinal and mixed-methods designs, participatory evaluation, and tracer studies are needed to link learning experiences to civic action and green career pathways (Barth & Rieckmann, 2022; OECD, 2023).

Pedagogical Directions for High-Quality Learning For Sustainability

The pursuit of sustainability in education requires a reorientation of pedagogy toward approaches that empower learners with the knowledge, skills, values, and dispositions necessary for addressing complex global challenges. High-quality learning for sustainability extends beyond content delivery, emphasizing transformative, participatory, and action-oriented pedagogies.

1. Problem- and project-based learning anchored in local sustainability challenges (energy audits, watershed monitoring, zero-waste initiatives) with community partners.
2. Transdisciplinary studios where students, educators, practitioners, and policymakers co-design solutions.
3. Futures and design thinking to cultivate anticipatory and strategic competencies via scenario planning and back casting.
4. Critical and justice-oriented pedagogies that surface power, trade-offs, and ethics in sustainability dilemmas.
5. Place-based and Indigenous knowledge integration to sustain cultural relevance and biocultural diversity.
6. Digital and data literacies for interpreting climate datasets, life-cycle analyses, and systems models paired with deliberation on data ethics.
7. Student leadership and youth participatory action research to strengthen agency and civic engagement.

Strategies for Implementation

Translating the vision of sustainability-oriented education into practice requires deliberate, multi-level strategies that align policy intentions with institutional realities and classroom practices. Implementation is most effective when it is supported by coherent frameworks, adequate resources, and collaborative engagement among stakeholders.

Policy and Governance

Embed learning for sustainability in standards, inspections, and accreditation; align funding with whole-institution sustainability plans; require public reporting on campus emissions, biodiversity, and community engagement (UNESCO, 2021; OECD, 2023).

Professional Learning Ecosystems

Scale networks that provide mentoring, open resources, and micro-credentials in sustainability competencies; support cross-sector residencies (schools ↔ NGOs ↔ municipalities) to build boundary-spanning expertise (Leal Filho et al., 2021).

Partnerships and Living Labs

Formalize partnerships for real-world briefs; treat campuses as testbeds for energy, mobility, water, and food innovations with student co-ownership.

Assessment Reform and Evidence

Co-develop rubrics for systems thinking, futures literacy, and civic action; invest in research-practice partnerships to generate usable evidence and share open data (Barth & Rieckmann, 2022).

Implications for Education and Society

Integrating sustainability into education carries profound implications not only for teaching and learning but also for the broader social fabric. At the educational level, embedding sustainability principles reshapes the curriculum, pedagogy, and institutional culture. Schools and universities that adopt sustainability frameworks become laboratories of innovation, where learners acquire not only disciplinary knowledge but also critical competencies such as problem-solving, ethical reasoning, and systems thinking. This shift enhances the relevance of education in addressing contemporary global challenges, ensuring that learners are equipped to navigate complexity and uncertainty in their personal and professional lives. From a societal perspective, education for sustainability contributes to the cultivation of responsible citizens who are prepared to engage in collective action for environmental stewardship, social justice, and economic resilience. By fostering awareness of intergenerational equity and global solidarity, education creates pathways for civic participation and empowers individuals to influence public policy and community development. In

this sense, classrooms serve as incubators for social transformation, where students translate knowledge into practical action that benefits both local communities and the global commons. Furthermore, the implications extend to **policy and governance systems,** as the integration of sustainability into education requires long-term investments, cross-sectoral partnerships, and supportive legislative frameworks.

Societies that prioritize sustainability in education are more likely to achieve progress toward the United Nations Sustainable Development Goals, particularly those related to climate action, reduced inequalities, and quality education. Conversely, the failure to embed sustainability in education risks perpetuating inequities, environmental degradation, and social fragmentation. Ultimately, the dual implications for education and society highlight that sustainability-oriented learning is not simply an academic exercise but a transformative process. By aligning educational practices with societal needs, education becomes a catalyst for building resilient, inclusive, and future-ready communities.

Conclusion

Learning for sustainability is not an optional addition to education systems but a foundational necessity for addressing the crises of the 21st century. As this paper highlights, progress requires moving beyond fragmented initiatives toward systemic integration of sustainability into policies, curricula, pedagogy, and institutional cultures. Success depends on embedding sustainability into national education frameworks, supporting teachers as key change agents, and fostering whole-institution approaches that align governance, operations, and community engagement. At the societal level, sustainability-oriented education cultivates responsible citizens who are equipped to navigate complexity, challenge unsustainable norms, and co-create just and resilient futures. While challenges remain ranging from resource limitations to inequities and technological risks the strategies outlined here emphasize the importance of collaboration, contextual adaptation, and continuous evaluation. Ultimately, the transformative potential of education lies in its ability to bridge knowledge and action, enabling learners not only to understand sustainability challenges but also to participate actively in building a more equitable and sustainable world.

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Original Article

Digital Transformation and Economic Development: Opportunities and Emerging Challenges

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Abstract

Digital transformation has emerged as a key driver of economic development, fostering productivity, innovation, and inclusion through the integration of advanced technologies such as artificial intelligence (AI), cloud computing, big data analytics, the Internet of Things (IoT), robotics, and blockchain. It enables new business models, streamlines processes, expands global market access, and enhances public service delivery. Moreover, digital transformation plays a vital role in promoting financial inclusion, digital literacy, and environmental sustainability through smart solutions for energy, agriculture, and urban systems. However, challenges such as infrastructure gaps, digital skill shortages, cybersecurity risks, financial constraints, and unequal access to technology hinder its widespread adoption. This paper explores the prospects and challenges of digital transformation for economic development, emphasizing the need for inclusive policies, digital literacy programs, public–private partnerships, and green digitalization strategies to ensure equitable and sustainable growth.

Keywords-Digital Transformation, Economic Development, Artificial Intelligence, Digital Inclusion, Green Digitalization, Financial Inclusion, Sustainable Development.

Introduction

Digital transformation is the process of using digital technologies to create new or modify existing business models, processes, products, services, or experiences. It has the potential to enhance productivity, efficiency, innovation, competitiveness, inclusion, and well-being in various sectors and domains of economic activity. However, it also poses significant challenges such as digital divide, cybersecurity, privacy, regulation, taxation, labor market disruption, social polarization, or ethical dilemmas. Digital transformation the integration of digital technologies across all sectors has emerged as a crucial driver of economic development, especially as countries transition toward knowledge-intensive economies. A longitudinal study spanning 2016–2020 demonstrates a strong positive correlation between sustained investments in digital capabilities (e.g., digital infrastructure, adoption rates, and talent development) and key economic indicators such as GDP growth, productivity, employment, and corporate investment (Lukmanova et al., 2024). Yet, the rollout and impact of digital transformation remain uneven across regions and demographics, raising concerns about inclusion, sustainability, and governance**.** In least developed countries (LDCs), for example, only 36% of the population is online, and mobile broadband costs consume nearly 6% of average monthly income, severely limiting access (World Economic Forum, 2024) Similarly, a report by the Cherie Blair Foundation reveals that 45% of female entrepreneurs in developing nations lack reliable internet access due to high data costs, with limited online privacy and safety further deepening the digital gender gap (Guardian, 2025). Moreover, productivity gains from digital technologies have yet to materialize uniformly.

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Advanced economies have seen slower aggregate productivity growth in recent years, despite substantial technological investments, and the benefits tend to concentrate among frontier firms exacerbating economic disparities and lowering broader growth rates (Brookings, 2024)

Background and Significance of Digital Transformation

Digital transformation the comprehensive integration of digital technologies into all facets of society and industry has reshaped how economies function, businesses operate, and individuals interact. Recent technological advancements in artificial intelligence (AI), cloud computing, big data analytics, the Internet of Things (IoT), robotics, and blockchain have catalyzed new business models, streamlined processes, and significantly enhanced productivity and user experiences (Suntsova, 2024). Economically, digitalization boosts competitiveness and innovation. A UK survey shows that 77% of SMEs adopting AI report productivity improvements, with substantial economic benefits projected potentially adding 470 billion to the UK economy by 2035 highlighting digitalization's long-term macroeconomic value. Globally, the ICT sector in OECD countries grew at an average of 7.6% in 2023, three times faster than the broader economy, underscoring its rising economic significance. Moreover, digital transformation enhances inclusion and access. The World Economic Forum's Edison Alliance achieved bringing essential digital services to 1 billion lives ahead of schedule, enabling underserved populations to access education, healthcare, and financial tools. Despite such progress, approximately 2.6 billion people remain offline, underscoring a persistent digital divide that risks exacerbating inequality if left unaddressed. On the governance front, governments leverage digital tools to improve service delivery and citizen engagement. Yet, implementing these systems demands foundational investments in infrastructure, literacy, and legal frameworks to uphold data privacy, cybersecurity, and responsible AI use. The UN Digital Economy Report (2024) further emphasizes the environmental impact of digital growth highlighting that the ICT sector consumes 6% to 12% of global electricity and calls for strategies toward sustainable digitalization through circular economy models. In summary, digital transformation stands as a powerful catalyst for economic and social advancement, offering productivity, inclusivity, and innovation. However, it brings complex challenges requiring coordinated policy interventions, investments, and equitable access to ensure its benefits are sustainable and widespread.

Prospects of Digital Transformation for Economic Development

The prospects of digital transformation for economic development are vast and encompass various areas that can positively impact economies. Here are some key prospects:

- Enhanced Productivity and Efficiency: Digital technologies enable automation, process optimization, and data-driven decision-making, leading to increased productivity and efficiency. Through digital transformation, businesses can streamline operations, reduce costs, and improve resource allocation. This efficiency gain can translate into higher economic output and competitiveness.

- Accelerated Innovation and Entrepreneurship: Digital transformation provides a fertile ground for innovation and entrepreneurship. It lowers barriers to entry, enables rapid prototyping and testing of ideas, and facilitates collaboration and knowledge sharing. Digital platforms and ecosystems foster the emergence of startups, enabling them to disrupt traditional industries and drive economic growth through novel products, services, and business models.

- Expanded Market Access and Globalization Opportunities: Digital technologies break down geographical barriers and enable businesses to access global markets. E-commerce platforms, digital marketing, and online marketplaces provide opportunities for small and medium-sized enterprises (SMEs) to reach customers beyond their local markets. This expansion of market access can lead to increased trade, foreign direct investment, and economic integration.

- Job Creation and Workforce Transformation: While digital transformation may disrupt certain job roles, it also creates new employment opportunities. The adoption of digital technologies leads to the emergence of new industries and job profiles, such as data scientists, cybersecurity experts, and digital marketing specialists. Moreover, digital transformation can augment human capabilities, enabling workers to focus on higher-value tasks that require creativity, problem-solving, and critical thinking.

Challenges of Digital Transformation for Economic Development

Digital transformation holds significant promise for economic growth, productivity, and inclusion. However, realizing its full benefits requires overcoming a series of deep-rooted challenges that span infrastructure, skills, policy, equity, and security.

Infrastructure and Access Constraints

Many low-income and developing countries struggle with limited and unreliable infrastructure. In the least developed countries (LDCs), only 36% of people are online, mobile broadband costs approach 6% of average monthly income, and smartphone prices can reach 95% of monthly earnings creating serious barriers to connectivity (World Economic Forum, 2024).

Skills and Talent Gaps

The rapid pace of technological advancement has outstripped workforce capabilities. Around 87% of executives expect skill shortages to impede strategy execution, and a Gartner report predicts digital skills gaps will prevent 60% of organizations from implementing their digital plans by 2026.

Financial and Resource Constraints

SMEs and public institutions often lack the resources needed for digital transformation. Upfront costs for infrastructure, platforms, and training deter adoption. In India, many MSMEs cite prohibitive costs as a major barrier to adopting AI tools. Research in Guangxi's SMEs echoes this: financial limitations, outdated technology, and organizational resistance significantly hinder digital uptake

Digital Transformation and Inclusive Growth

Digital transformation has the potential to act as a catalyst for inclusive growth, bridging socioeconomic gaps by providing access to essential services such as education, healthcare, finance, and public administration. Digital tools ranging from mobile banking applications to e-learning platforms and e-government services have already demonstrated their capacity to uplift marginalized communities, especially in regions where physical infrastructure is limited (World Bank, 2025). One of the most significant contributions of digital transformation lies in financial inclusion. Mobile money services such as M-Pesa in Kenya have enabled millions of unbanked individuals to access financial services, fostering entrepreneurship, reducing transaction costs, and stimulating local economies (World Economic Forum, 2024). Similarly, digital identity systems in India (e.g., Aadhaar) have allowed citizens to access government subsidies, health services, and banking, thereby strengthening social welfare delivery mechanisms (World Bank, 2025).

In the education sector, digital learning platforms and AI-powered adaptive learning systems have broadened educational opportunities for rural and underserved populations. During the COVID-19 pandemic, digital technologies enabled remote learning for millions, underscoring their role in ensuring educational continuity (UNESCO, 2023). Likewise, telemedicine and digital health records have enhanced healthcare access in remote regions, reducing barriers to essential medical services. Despite these opportunities, the digital divide remains a pressing concern. Approximately 2.6 billion people globally remain offline, primarily due to high internet costs, limited digital literacy, and inadequate infrastructure (International Telecommunication Union, 2024). Gender disparities further compound this divide; women in many developing countries face cultural, economic, and educational barriers that limit their access to digital technologies (Reuters, 2024).

To ensure inclusive digital growth, governments and development agencies must prioritize:

Affordable Internet Access: Investments in broadband infrastructure and public Wi-Fi initiatives can reduce connectivity costs.

- Digital Literacy Programs: Equipping marginalized groups with essential digital skills enhances adoption and economic participation.
- Gender-Sensitive Policies: Initiatives targeting women's access to technology can close gender gaps in education, entrepreneurship, and employment.
- Public–Private Partnerships: Collaborative efforts between governments, telecom operators, and technology firms can accelerate inclusive digital ecosystems.
- Ultimately, digital transformation must be designed with equity at its core. Without deliberate interventions, technological advancements risk deepening existing social and economic inequalities rather than alleviating them (OECD, 2025).

Environmental Sustainability and Digitalization

The intersection of **digital transformation** and **environmental sustainability** represents both an opportunity and a paradox. On one hand, digital technologies such as **Internet of Things (IoT) sensors, big data analytics, artificial intelligence (AI)**, and **smart grid systems** enable real-time monitoring and optimization of energy consumption, water use, waste management, and urban mobility. On the other hand, the **rapid expansion of digital infrastructure** including data centers, blockchain networks, and high-performance computing facilities poses significant environmental challenges due to rising energy demand and electronic waste (UNCTAD, 2024).

- **Opportunities for Sustainable Development**
- Digitalization offers innovative solutions for achieving **Sustainable Development Goals (SDGs)** by promoting green practices across industries:
- **Smart Energy Management:** AI-powered energy analytics optimize power distribution and reduce wastage in urban grids (IEA, 2024).
- **Sustainable Transportation:** Intelligent traffic management systems and electric vehicle (EV) charging infrastructure minimize emissions in smart cities (OECD, 2025).

- **Precision Agriculture:** Drones, IoT soil sensors, and satellite imagery improve crop yields while reducing fertilizer and water overuse (World Bank, 2025).
- **Climate Monitoring:** Big data and remote sensing technologies enable early warning systems for floods, droughts, and extreme weather, enhancing climate resilience (UNEP, 2024).

These applications illustrate how **green digitalization** can align economic development with environmental stewardship when appropriately designed and managed.

Conclusion

Digital transformation represents a paradigm shift that extends far beyond technological adoption; it reshapes economic structures, institutional frameworks, and societal interactions. As nations increasingly integrate advanced technologies such as artificial intelligence (AI), big data analytics, the Internet of Things (IoT), robotics, and blockchain, they unlock new avenues for innovation, productivity enhancement, and inclusive growth. The economic potential of digitalization is vast, enabling businesses to develop agile operational models, governments to implement efficient e-governance systems, and communities to access essential services in education, healthcare, and finance with unprecedented ease. However, the pathway to digital transformation is neither linear nor universally accessible. Regional disparities, infrastructural limitations, digital skill shortages, cybersecurity threats, and environmental challenges persist as significant barriers to equitable digital growth. The digital divide, particularly between developed and developing economies, threatens to reinforce existing socioeconomic inequalities unless proactive measures ensure universal digital inclusion. Moreover, environmental concerns, such as the energy-intensive nature of data centers and growing e-waste volumes, highlight the urgent need for green digitalization strategies that balance technological progress with sustainability imperatives. To harness the full potential of digital transformation for economic development, multi-stakeholder collaboration is essential. Governments must design comprehensive digital policies emphasizing data security, ethical AI, and digital literacy, while the private sector should invest in affordable infrastructure and innovative digital solutions tailored to local contexts. International organizations can play a vital role in knowledge sharing, capacity building, and financing digital inclusion programs to bridge gaps across regions. Furthermore, future digital strategies must integrate social equity, environmental stewardship, and economic resilience as core principles. Initiatives like smart cities, digital public goods, and sustainable ICT ecosystems should align with the Sustainable Development Goals (SDGs) to ensure that technology serves as a force for inclusive and environmentally responsible growth. Ultimately, digital transformation offers transformative opportunities for economic diversification, job creation, and global competitiveness, but realizing these benefits requires strategic vision, inclusive policies, and ethical governance. A deliberate, collaborative, and sustainability-oriented approach will enable nations to transform digital challenges into opportunities, ensuring that the digital economy becomes a catalyst for long-term equitable and sustainable development.

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Original Article

Entrepreneurship and Startups as Drivers of Sustainable Economic Growth in SAARC Nations

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Abstract

Startups and entrepreneurship are becoming more widely acknowledged as vital catalysts for long-term economic expansion, especially in developing nations like the SAARC. The SAARC nations provide tremendous potential for the growth of entrepreneurship due to their varied economies, wealth of human capital, and distinctive sociocultural settings. This essay investigates how startups and entrepreneurship support innovation, create jobs, and advance equitable and sustainable regional growth. It emphasizes how digital innovations, green technologies, and sustainable business models help companies address social and environmental issues. The report also looks at the infrastructure, financial ecosystems, and policy frameworks needed to promote entrepreneurial endeavours in SAARC countries. Important issues are covered, including insufficient cross-border cooperation, restricted access to financing, and regulatory obstacles. In order to fully realize startups' potential as engines of sustainable economic development in SAARC nations, the paper ends with recommendations for ways to improve the entrepreneurial ecosystem, highlighting the significance of regional cooperation, governmental initiatives, and private sector involvement.

Keywords: *Entrepreneurship, Startups, Sustainable Regional Growth, Innovation, SAARC Nations, Regional Cooperation*

Introduction

Startups and entrepreneurship have become essential foundations of innovation, sustainability, and economic transformation in the twenty-first century. Globally, entrepreneurship has been acknowledged as a driving force for social change and technological advancement in addition to creating jobs. The development of entrepreneurship is especially important for emerging regions like the countries that make up the South Asian Association for Regional Cooperation (SAARC), which includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. These countries are in a great position to use startups to achieve long-term, inclusive, and sustainable growth because of their youthful populations, growing expectations, and plenty of natural and human resources. Unemployment, poverty, economic inequality, and environmental degradation are among the developmental issues that the SAARC economies face in common. Traditional growth models, which rely on resource exploitation and heavy industries, frequently fall short in providing a sustainable solution to these urgent problems. By promoting innovative ideas that strike a balance between social and environmental responsibility and financial prosperity, entrepreneurship provides a workable alternative in this situation. Startups in sectors including agribusiness, financial Technology, health care, education, and renewable energy are already making a big difference in closing the region's developmental divide. Many of these initiatives are addressing underprivileged populations by utilizing digital technologies, which is fostering inclusive growth.However, there are several barriers to entrepreneurship in SAARC countries.

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The key obstacles continue to be poor policy support, bureaucratic roadblocks, limited financial availability, and inadequate infrastructure. Additionally, regional cooperation is still in its infancy, which results in lost chances for joint ventures, cross-border trade, and information exchange. In spite of these However, success stories from Bangladesh's apparel-based business initiatives, India's thriving startup environment, and Nepal's growth in tourism-focused businesses show the revolutionary potential of entrepreneurship when fostered in environments that are encouraging.

The fact that entrepreneurship is in line with the Sustainable Development Goals (SDGs) of the UN further emphasizes its importance for sustainable development. Startups that tackle environmental and social issues like waste management, women's empowerment, sustainable energy, and skill development have a direct impact on reaching global development goals. Promoting entrepreneurship is not only economically necessary but also strategically vital for sustainable growth in SAARC countries, where socioeconomic gaps and demographic pressures are apparent. The purpose of this study is to investigate how startups and entrepreneurship might promote sustainable economic growth in SAARC countries. It looks at the opportunities and difficulties that local entrepreneurs confront, evaluates how institutions and governments influence startup ecosystems, and offers suggestions for enhancing entrepreneurship-led growth through regional collaboration and legislative initiatives.

Literature Review

Startups and entrepreneurship are becoming more widely acknowledged as drivers of economic change, especially in developing nations like South Asia. Because they provide both direct employment possibilities and indirect income through supplier chains and service links, startups play a key role in job development. In comparison to older companies, new initiatives are disproportionately responsible for creating jobs, according to Acs (2014). This opinion has been supported by recent South Asian assessments. Manzoor, Wei, Nurunnabi, and Subhan (2019), for example, used panel data to show how SMEs and startups dramatically lower unemployment and poverty in SAARC countries, underscoring their potential as instruments of inclusive growth. Similarly, Kadakia (2024) reported that, especially in technology-driven industries, Indian startups alone generated millions of employment between 2019 and 2023.Entrepreneurship is linked to innovation and competitiveness in addition to employment. Since entrepreneurs are upending traditional markets with innovative goods, services, and business strategies, Schumpeter's idea of "creative destruction" is still very applicable today. In industries that increase productivity and expand market access, such as fintech, agritech, and digital services, South Asian entrepreneurs have played a significant role, according to the World Bank (2018). More recent studies, including the OECD's Start-up Asia (2025), highlight how quickly entrepreneurs in the area are emerging as innovation leaders, advancing technology and spreading knowledge across industries. A third aspect is socio-economic development, when business endeavours contribute more broadly to sustainability, social mobility, and poverty alleviation. By supporting women entrepreneurs and green startups, entrepreneurship promotes gender equity and environmental resilience, according to the United Nations Development Programme (2020). This was reaffirmed by the World Intellectual Property Organization's Global Innovation Index 2024, which recognized social entrepreneurship as a force behind inclusive development and highlighted its increasing significance in tackling issues including health, education, and climate change. In addition, ERIA's One-ASEAN Start-up White Paper (2024) emphasized that the degree to which startups may effectively contribute to socio-economic transformation is still determined by regulatory frameworks, financial accessibility, and digital infrastructure. All together, these findings indicate that although SAARC startups have shown a great deal of promise in generating employment, promoting innovation, and bolstering inclusive growth, their ability to have a developmental impact depends on the enabling ecosystem. Entrepreneurial activity has the risk of staying concentrated in urban centers and failing to reach excluded communities in the absence of institutional support, funding sources, and capacity building. Therefore, creating an atmosphere that is favourable to entrepreneurship is still essential to use startups as catalysts for regional sustainable development.

Research Methodology
1 Research Design

A descriptive and exploratory research design based on secondary data analysis is used in this study. Examining how startups and entrepreneurship support innovation, inclusive growth, job creation, and sustainable development in SAARC countries is the goal

2 Nature of Study

The study is qualitative in character and focuses on interpreting and synthesizing reports, scholarly contributions, and data that already exists. To bolster the analysis, quantitative insights are integrated from databases and published statistics.

3 Data Collection Method

A rigorous evaluation and synthesis of pertinent literature, data reports, and policy papers from the past ten years was conducted. Official publications, institutional websites, and scholarly databases were used to gather data.

4 Scope and Delimitation

- The study focuses on **SAARC member nations** (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka).
- The scope is limited to **secondary data sources**, hence primary surveys and interviews are not included.
- The time frame is restricted to literature and data published between 2015 and 2025 to ensure relevance and recency.

5 Limitations

- Dependence on the availability and reliability of secondary data.
- Possible variations in data reporting and measurement standards across SAARC countries.
- Limited availability of comparable startup ecosystem data in smaller SAARC nations.

Objective of the Study

Analyzing how startups and entrepreneurship contribute to sustainable economic growth in SAARC countries is the main goal of this study. The study specifically seeks to:

1. Analyze how startups and entrepreneurial endeavours contribute to innovation, job creation, and socioeconomic growth in the area.
2. Evaluate startups' potential as engines of environmental sustainability, poverty reduction, and inclusive growth.

1 Analyze how startups and entrepreneurial endeavours contribute to innovation, job creation, and socioeconomic growth in the area.

This study's primary goal is to examine the ways in which startups and entrepreneurial endeavours support innovation, job creation, and socioeconomic advancement in the SAARC area. In recent years, significant information has been provided by international organizations like the World Bank, WIPO, and the OECD that directly supports this line of investigation.

Job Creation: According to the World Bank (2024), South Asia continues to struggle to create enough jobs to accommodate its quickly growing working-age population. Small businesses and startups are seen as essential to addressing this "missing engine" of development since they generate a variety of employment options, from informal and gig-based work to specialized positions in the technology industry. The region can access new labour markets and lower structural unemployment, especially among women and young people, by promoting entrepreneurship. This closely relates to the goal of evaluating how startups contribute to the creation of jobs in SAARC countries.

Innovation: The Start-up Asia (2025) report from the OECD emphasizes how crucial startups are to Asia's productivity development and innovation. Startups are largely in charge of implementing and spreading new technology, testing out creative business plans, and encouraging competition that boosts output. Startups are revolutionizing service delivery and developing scalable solutions for expanding countries, particularly in industries like finance, agritech, and health tech. This data shows that innovation is a direct result of entrepreneurship and a catalyst for more extensive socioeconomic change.

Socio-Economic Development: The WIPO Global Innovation Index 2024 emphasizes how social entrepreneurship and green startups are becoming increasingly significant in promoting sustainable and inclusive development. Startups address urgent societal issues like financial inclusion, climate change, and fair access to healthcare and education in addition to contributing to economic indicators like GDP and employment. These contributions to the environment and society show how startups go beyond conventional commercial goals to promote comprehensive socio-economic development in accordance with the Sustainable Development Goals (SDGs) of the UN. When taken as a whole, these international studies show that startups and entrepreneurial endeavours are not just drivers for innovation and job creation, but also for equitable and long-term socioeconomic advancement. Examining this contribution in the SAARC region is therefore critical, as it allows policymakers and scholars to understand how entrepreneurship can be leveraged to address structural employment deficits, stimulate innovation-led growth, and promote equitable development.

2 Evaluate startups' potential as engines of environmental sustainability, poverty reduction, and inclusive growth.

Mechanisms by which startups drive inclusive growth

Startups contribute to inclusive growth by creating diverse, localized economic opportunities and lowering barriers to market entry for under-represented groups. Policy research from the OECD highlights "inclusive entrepreneurship" policies (training, microfinance, tailored incubators) that expand access to business creation for women, youth, migrants and disadvantaged groups — thereby helping growth reach broader segments of society. Startups often operate in niche markets or use digital platforms to reach customers previously excluded from formal markets, widening participation in economic activity.

Pathways to poverty alleviation

Social enterprises and inclusive startups directly target poverty by supplying affordable goods and services (micro-finance, low-cost health and education, market linkages for small producers) and by generating incomes in low-income

communities. Global and regional evidence reviews show social entrepreneurship can reduce vulnerability and raise household incomes when scaled and supported; case studies in South Asia (e.g., Pakistan, Bangladesh) document poverty-reducing impacts from locally embedded social ventures. The World Bank's recent poverty and sustainability analyses stress integrated approaches (jobs + services + sustainability) for durable poverty reduction — a space where mission-driven startups can contribute measurably.

Contribution to environmental sustainability

Startups (especially "green" and climate-tech ventures) innovate with low-carbon products, circular-economy models, and resource-efficient services—helping decouple growth from environmental degradation. The World Bank's Global Program on Sustainability and OECD analyses show that targeted financing (green bonds, blended finance) plus policy nudges can scale environmentally positive startups; WIPO's Global Innovation Index (2024) highlights social and green entrepreneurship as rising contributors to sustainable development goals.

Important caveats & enabling conditions

Reports emphasize that startups alone are insufficient: their potential depends on finance (VC, blended finance), enabling regulation, digital infrastructure, and skills (human capital). Without inclusive policies, startup benefits often cluster in urban tech hubs and fail to reach marginalized or rural populations. The GII and OECD stress ecosystem strengthening — incubators, gender-sensitive programs, and linkages to MSMEs — to translate startup activity into broad-based development.

Findings and Conclusion

The study concludes that entrepreneurship and startups are critical drivers of sustainable economic growth in SAARC nations. They not only create jobs and stimulate innovation but also address broader developmental challenges, including poverty alleviation, social inclusion, and environmental sustainability. Startups are in a unique position to provide innovative, scalable, and locally relevant solutions to the socioeconomic issues that South Asian economies face. However, the results also show that structural issues including restricted financial access, regulatory obstacles, poor infrastructure, and unequal ecosystem development among SAARC countries limit the potential of entrepreneurs. Smaller nations like Bhutan, the Maldives, and Afghanistan lag behind because of inadequate institutional support, but India exhibits quick improvement with a developed startup ecosystem. SAARC countries must make investments in digital infrastructure, financial inclusion, cross-border cooperation, policy assistance, and capacity-building initiatives in order to optimize the effects of entrepreneurship. Startups can be a strategic means of attaining the UN Sustainable Development Goals (SDGs) in South Asia as well as economic growth if they work hard.

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Original Article

Role Of Automation And Ai In Enhancing Operational Efficiency Of Renewable Energy Projects In Karnataka

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Abstract

   Recent advancements in data science and artificial intelligence, along with the development of clean and sustainable energy sources, have created significant opportunities for researchers in the energy sector. Artificial Intelligence (AI) and Machine Learning (ML) techniques have been increasingly applied to renewable energy, with their scope and impact expanding considerably in recent years.

   The energy department in Karnataka is exploring the use of AI to enhance professionalism in the operations and management of electricity distribution, thereby strengthening the state's power sector. While AI and ML have a wide range of applications, selecting and implementing the most appropriate methods for future research remains a challenge. The department has emphasized that although AI will be adopted more extensively in the future, this will not result in job losses. Instead, AI will contribute to better skill management and help reduce both financial and power losses. AI is already being used to monitor power supply and generate projections for future energy needs.

   To address these developments, this study reviews several of the most widely recognized AI techniques in renewable energy, including geothermal applications. The paper highlights the most prevalent renewable energy system (RES) modeling and optimization algorithms. More than 20 studies published between 2024 and 2025 have been compiled and organized in the results section according to the methods employed and the fields of application. Finally, the results are discussed, the limitations of the current study are outlined, and recommendations are provided to enhance the scope and practical value of this research.

Keywords: Artificial Intelligence, Machine Learning, Renewable Energy, Geothermal, Modeling and Optimization Algorithms.

Introduction

   Global energy demand is projected to increase by an average of 8% per year between 2020 and 2030. Currently, fossil fuels account for a major share of the world's energy supply, exerting profound environmental and economic impacts. To address these challenges, many developed and developing countries have adopted policies promoting renewable energy sources such as wind and solar power, thereby reducing their dependence on fossil fuels. Renewable energy has emerged as one of the most viable alternatives to fossil fuels, offering solutions to critical issues such as fuel price fluctuations, population growth, and environmental concerns, including global warming. Moreover, hybrid energy systems that combine sources such as wind, solar, and hydrogen provide greater diversity and flexibility in power generation.

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A significant body of research has been conducted on renewable hybrid systems, focusing on aspects such as optimal system sizing, supply management, and integration with storage technologies. Given the intermittent nature of renewable resources—particularly wind—energy storage solutions are increasingly being developed to ensure stability and reliability.

In the 21st century, data has become a powerful enabler for modeling and optimization across multiple scientific domains. Effective data-driven approaches can reduce the negative environmental impacts of energy systems—such as carbon footprints, greenhouse gas emissions, and ozone depletion—which were identified as key global challenges in the Paris Agreement (2015). Thus, a data-driven framework is essential for improving the energy, economic, and environmental performance of renewable energy systems. Artificial Intelligence (AI) and Machine Learning (ML) are relatively recent yet promising tools in the energy sector. By leveraging past data and predictive modeling, these technologies can enhance the efficiency, control, and adaptability of energy systems. AI encompasses a wide range of data-based methods capable of solving complex energy-related challenges. Although implementing AI methods poses certain difficulties, they enable machines to "learn," adapt, and improve system performance. With advances in ML and data-driven modeling, the management and optimization of energy resources has become more effective and practical than ever before. Prediction models are generally categorized into three types:

- Black box models, such as neural networks, directly map inputs to outputs.
- White box models, based on physical principles, use system data to forecast outcomes.
- Grey box models, which combine features of both black box and white box approaches.

In Karnataka, the Central Government has approved, in principle, the implementation of the Revamped Distribution Sector Scheme (RDSS), allowing two years for the rollout of smart meters for all consumers at affordable rates. The scheme is currently set to conclude in December 2025. Once implemented, smart meters will be provided to consumers at nominal costs, as seen in other Indian states. Discussions with the Union Minister for Power emphasized that pending dues—amounting to approximately ₹10,000 crore from various government departments such as the Rural Development and Panchayat Raj, Urban Development, and BWSSB—must be cleared before the subsidized rollout of smart meters. This is one of the Ministry of Energy's key conditions, as reducing financial arrears is essential for improving efficiency in power distribution.

The department has also undertaken initiatives to reduce transmission and distribution losses, including the installation of high-performance conductors to enhance carrying capacity. In addition, three 765 kV substations are being constructed in Central, North, and South Karnataka, along with 37 substations of 400 kV each across the state. These infrastructure projects are scheduled for completion within the next four years, strengthening Karnataka's energy grid and supporting its transition toward a more sustainable, technology-driven power sector.

Literature Review

Several studies have been conducted in the area of Artificial Intelligence (AI) and Machine Learning (ML) with a focus on renewable energy. Some of the most relevant are outlined below.

S.F. Moosavian et al., in their study "Renewable Energy Resources Utilization Planning for Sustainable Energy System Development on a Stand-Alone Island," conducted a comprehensive review of energy demand sectors, including electricity, heating, cooling, and transportation. Using the Energy Plan software tool for energy modeling, they presented different scenarios to increase the share of renewable energy and reduce fossil fuel dependency by incorporating technologies such as solar, wind, biomass, and hydrogen. Similarly, Aseel Bennagi et al., in their work "Comprehensive Study of Artificial Intelligence Applied in Renewable Energy," emphasized AI approaches in renewable energy, particularly their advantages and limitations in solar and wind systems. Their study included four case investigations that demonstrated the efficient integration of AI in renewable energy systems.

Over the past few decades, significant research has been devoted to the exploitation of sunlight and wind as primary renewable energy sources (RES). This shift has directed attention to renewable technologies such as photovoltaic (PV), wind, geothermal, hydropower, tidal, and biomass systems. These technologies contribute to the transformation of the power sector by controlling electricity costs, enhancing system stability, replacing outdated infrastructure, reducing CO_2 emissions, and improving energy access in remote areas. To complement these developments, energy storage systems (ESS) have been developed to address the intermittent nature of renewable sources and improve the accuracy of renewable energy forecasts. AI has emerged as a transformative technology for renewable energy. While earlier systems relied on basic decision-making and monitoring, modern AI techniques allow for intelligent data-driven management, forecasting, and optimization. AI is now applied across multiple sectors—including energy, agriculture, healthcare, and education—and plays a critical role in advancing sustainability. In the renewable energy domain, AI influences both policy and economics by modeling different scenarios, evaluating policy effectiveness, and predicting economic impacts of energy strategies. It also supports ecosystem monitoring, carbon footprint measurement, and resource optimization, all of which help reduce environmental impacts. Importantly, AI also enables solutions that expand access to clean and affordable energy in marginalized communities.

Research has increasingly focused on applying AI-based metaheuristic methods to improve the performance of solar energy systems. Multiple AI algorithms have been integrated with numerical models to estimate, predict, and forecast characteristics of renewable resources such as solar and wave energy. In bioenergy, AI-based processes are being used in biotechnology and chemical engineering to optimize advanced biofuels, helping reduce carbon emissions in transportation and industry.

One example is the application of recurrent neural networks to forecast the performance of solar stills, predicting both thermal efficiency and water yield. Similarly, low-cost bilayer structures have been developed to enhance solar still performance using AI-based predictive modeling. AI approaches are also widely applied to predictive maintenance, improving the safety and reliability of renewable systems, minimizing environmental impacts, and increasing cost-effectiveness. In addition, AI supports more accurate productivity forecasting for solar cells, facilitates the expansion of microgrids and smart grids, and identifies optimal procedures for renewable resource integration. This paper reviews a broad panorama of the evolution of AI and renewable energy research. The aim is to highlight state-of-the-art renewable energy technologies enhanced through AI tools and techniques, particularly in energy conservation, control, and administration. The findings are intended to support researchers, engineers, and practitioners by providing an overview of current AI-driven renewable technologies in solar, hydro, and wind energy. The review also discusses the challenges of deploying AI-based systems in renewable energy, including data-related issues, and outlines potential solutions and future research directions.

Methodology

A primary objective of this research is to develop a vision for using machine learning methods in different parts of energy systems in the future, which will serve as a guideline for other researchers, engineers, and decision-makers in the energy field who are not familiar with AI concepts and their applications in the field of RES. In addition, choosing the proper artificial intelligence methods can lead to better and faster development of sustainable energy systems worldwide.

Power Scenario In Karnataka

The current Power Supply Position for Karnataka is shown below:

Table 1:- Power Supply Position: 2021- 2025

	Power Supply Position					
Year	Energy required (MU)	Energy Supplied (MU)	Energy Not Supplied (MU)	Peak Demand (MW)	Peak Met (MW)	Demand Not Met (MW)
2021-22	72,437	72,417	20	14,830	14,818	12
2022-23	75,688	75,663	26	15,828	15,828	0
2023-24	94,088	93,934	154	17,212	17,212	0
2024-25	92,450	92,446	4	18,395	18,395	0

As of March 2024, the total contracted capacity for Karnataka is 23,868 MW. Out of the total contracted capacity (CC), the share of non-fossil fuel-based CC is 60%. The fuel-wise contracted capacity as of March 2024 is given in the table below.

Table 2:- Fuel-wise Contracted Capacity as of March 2024

Source	Contracted Capacity (MW)	Percentage
Coal	9614	40%
Nuclear	698	3%
Hydro	4401	19%
Wind	3197	13%
Solar	5524	23%
Biomass & Co-gen	435	2%
Total	**23868**	**100%**

Peak and Energy Demand for the State of Karnataka, as furnished by the utility, were considered for carrying out the resource adequacy study for the state. The demand data in terms of peak and energy requirement is furnished in the Table below.

Table 3:- Future Demand Projection by Karnataka

	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
Energy Projections (MU)	100066	107998	118181	125868	134910	144142	153230	164064	176022	189667
Year-on-Year Growth (Energy)	8.0%	7.9%	9.4%	6.5%	7.2%	6.8%	6.3%	7.1%	7.3%	7.8%
Peak Demand Projections (MW)	18075	19690	21745	23372	25051	26765	28453	30464	32685	35218
Year-on-Year Growth (Peak)	9.0%	8.9%	10.4%	7.5%	7.2%	6.8%	6.3%	7.1%	7.3%	7.7%

Future hourly demand profile till the year 2034-35 has been projected, taking the demand profile of 2023-24 as a base profile. The actual hourly solar & wind generation profiles have been referred from data received from Karnataka, and CUFs have been considered as per the inputs received from Karnataka. Capital cost of candidate plants for coal, wind, solar, battery, and PSP, considered investment options for the studies, has been as per the current market prices.

Overall, this study provides a comprehensive, advanced, and recent output developing in the field of AI applications in RE technologies with experimentally implemented AI methods and their deployments in different RE technologies and systems, specifically in solar energy and wind energy systems. Along with covering the possible challenges and giving their possible solutions, this review also projects some future trends and possible directions in the field. All data variables present at one review will provide assistance to researchers and investigators to have a clearer outlook and grip on the field. Considering the wide application of artificial intelligence and machine learning methods, the rapid development of renewable energy sources, and the increasing interest in using new technologies in energy systems, this paper attempts to introduce various artificial intelligence methods for modeling, optimizing, and classifying their applications in renewable energy systems. To fulfill these purposes, at first, in the method part, a brief overview of each method is presented with the necessary information to understand and deploy them. Then, in the Results section, a comprehensive review will be conducted on the applications of each method, and they will be categorized based on the share of usage in different parts of renewable energy systems (e.g., solar systems, wind systems, etc.) in the Discussion. Finally, the conclusion section will summarize the activities performed during the current study.

Methods

In this section, artificial intelligence and machine learning methods are classified into two groups: modeling methods and optimization methods. Detailed descriptions of each are provided below.

Discussion

A number of the most well-known and widely utilized AI modeling and optimization techniques have been subjected to a comprehensive investigation. The most important question to ask in this situation is which method (or methods) would be most appropriate for solving our problems? In fact, the performance of the various methods that were described in detail differed, and this was due to a variety of factors.

Results

This section presents the findings of a classification performed on several research papers published over the past two years, based on the methodologies applied in their analyses. AI methods were broadly categorized into two groups: modeling methods and optimization methods.

The study considered only existing and planned capacities while assessing compliance with the annual Renewable Purchase Obligation (RPO). It was observed that the total unserved energy in the year 2034–35 amounts to approximately 19,586 MU.

Further, the study analyzed the Aggregated Hourly Unserved Energy for Karnataka in 2034–35. As illustrated in Figure 7, unserved energy primarily coincides with peak demand months, when the contracted capacity (both existing and planned) falls short of meeting the demand.

The findings indicate that Karnataka will need to contract additional capacities (planned and new) annually until 2034–35 to meet demand reliably while ensuring compliance with RPO obligations. The detailed capacity requirements are summarized in the table below.

Table 4:- Year-wise Capacity Addition for Karnataka (in MW)

FY	Wind		Solar	
	Planned	Additional	Planned	Additional
2025-26	0	0	2310	0
2026-27	1000	0	1500	0
2027-28	1000	750	1000	0
2028-29	200	750	200	0
2029-30	1000	750	1000	2000
2030-31	1000	750	1000	1430
2031-32	0	750	0	0
2032-33	0	750	0	1021
2033-34	0	750	0	926
2034-35	0	750	0	1688

Conclusion

With growing environmental concerns, particularly global warming, there has been increasing emphasis on the expansion of renewable energy sources. Many researchers have focused on the development, simulation, modeling, and experimental testing of renewable energy systems, ranging from household applications to state and national levels.

This study was carried out to assess the resource adequacy of Karnataka, based on demand projections provided by the state. Currently, about 40% of Karnataka's installed capacity (IC) comes from fossil fuel sources. The analysis was conducted using the hourly load pattern for 2023–24, where the peak demand month was identified as March.

Findings indicate that Karnataka is likely to face an energy deficit from 2025–26 to 2034–35, even when considering existing and planned capacity, along with Distributed Renewable Energy (DRE) capacity required to meet Renewable Purchase Obligations (RPOs). Additional renewable capacity, totaling around 13,605 MW of solar and wind, has been considered from 2027–28 onwards, accounting for the time required to finalize new renewable plants—from tendering to commissioning.

The study observes that the total unserved energy in 2034–35 will be significant, with the shortfall being highest during non-solar hours throughout the year. To address this, the model provides various investment options for generation capacity, ensuring both adequacy and compliance with RPOs.

The results suggest that a 5% Planning Reserve Margin (PRM) should be maintained to meet reliability criteria, considering solar capacity credit as zero, since peak demand occurs during non-solar hours. Additionally, the study highlights year-wise short-term, medium-term, and bilateral capacity requirements to optimally meet demand.

Interestingly, Karnataka is also projected to have a surplus capacity of about 2,395 MW during June–August of FY 2027–28, which could potentially be shared with other states/utilities.

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Original Article

Organic Farming and Sustainable Development in SAARC Nations: Key Issues, Opportunities, and Challenges

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Abstract

Agriculture plays dominant role in South Asian economy that provide jobs to rural people and provide food security to almost about two billion south Asian citizens but continuous conventional farming in which there is excessive use of chemical fertilizers, pesticides and other agrochemicals are responsible for numerous problems of sustainability which comprises long term human health hazard, soil erosion, loss of biodiversity and water pollution. Organic agriculture has emerged as an appropriate replacement to conventional agriculture in the countries of the South Asian Association for Regional Cooperation (SAARC) which comprise eight members i.e., Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka, that addresses all the environmental problems and supports sustainable development.

This paper is exploring the interlinkage between organic farming and the theme of the conference i.e., "Sustainability and Development in SAARC Nations: Key Issues, Opportunities, and Challenges," It assesses the promise that organic farming holds out for sustainable livelihoods, highlights the salient issues which agriculture in the region confronts, and explores the challenges that remain between the region and universal acceptance. The article discusses how organic farming can integrate ecological harmony with economic growth through examples such as the transition of Sikkim towards completely organic farming, Bhutan's national vision of organics, and policy learnings from Bangladesh and Sri Lanka. Policies regarding SAARC knowledge transfer, trade facilitation, and regional coordination are also covered. Organic farming can be a central part of South Asia's sustainable development agenda if it is supported with rational policies, institutional support, and regional coordination, the study concludes based on its findings.

Keywords: SAARC nations, organic farming, sustainability, agriculture, development, opportunities, and challenges Over-extraction

Introduction:

One of the key symbols of the 21st century is sustainable development which understands the fundamental requirement of reconciling social justice, economic prosperity, and nature protection. The SAARC province, which covers Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka, is the region where this task is spectacularly announced. Nations like these, which conjointly represent approximately 25% of the universal population, enclose among the most distinct ecological subdivisions on the planet, from barren deserts and seaside environments to Himalayan ice fields and fertile river flatlands.

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How to cite this article:

Nearabout 60% of the work force operate in the field of agriculture, which remains the backbone of this zone and establish both rural livelihoods and national economies. Deep-rooted pliancy is challenged by the deep regional crises, which caused loss of biodiversity, soil erosion, water scarcity, and the increasing uncertainty of climate change. South Asia observed a sea change through the 1960s and 1970s Green Revolution that advocated self-sufficiency of food by virtue of high-yielding crop varieties, pesticides, chemical fertilizers, and developing irrigation. This complete change had huge ecological damage despite alarming the risk of natural calamities such as famine. Over-extraction of groundwater, over-utilization of agrochemicals, and even monoculture have disintegrated soils, contaminated rivers and aquifers, reduced crop diversity, and reinforced greenhouse gas emissions. The small farmers, comprising the large majority of the SAARC agricultural zones and still highly undefendable to shocks, are presently captured in a cycle of growing input costs and lowering productivity.

Moreover, organic farming is progressively recognized as a practicable substitute that encircles social, economic, and environmental dimensions of sustainability. Some of the techniques such as Crop rotation, composting, mulching, and biological pest control are involved in organic farming, which is specified as a system that reduces synthetic inputs, primarily focuses ecological balance, and promotes biodiversity. Methods like these tries to reduce reliance on expensive exterior inputs, advances soil health, and helps to conserve water. Besides its valuable impacts on the environment, organic farming reinforces rural enterprise, ecotourism, livelihood diversification, and access to invaluable domestic as well as international markets - a large group of concerns intimately linked to the multi-dimensional objectives of sustainable development.

Organic farming, aside from ecology, is proved to be rich in opportunity for the SAARC zone. Markets outside the province for organics are continuously developing and improving health consciousness among middle-class consumers and also have growing demand for chemical-free, safe and healthy food. Though, Bhutan has pointed out its motif to go completely organic, countries like India and Sri Lanka by the time export spices, organic tea, and basmati rice. It was in 2016 when the Indian state of Sikkim was the first completely organic state in history of world, proving the game-changing power of this approach to brand-building, economic diversification, and even identity. There are also significant hurdles to universal adoption. Food security issues exist due to the fact that a transition from conventional to organic agriculture often leads to early yield reductions. The cost complexity and unaffordability of certification schemes restrict market access. Organic produce storages, processing units, and marketing infrastructures prove inadequate, minimising competitiveness and ultimately leading to losses. Policy environments are also trailing; funding for organic research, expansion, and even farmer training also remains inadequate, and subsidies on chemical fertilizers liger. The hazards of ill-conceived changes are demonstrated by Sri Lanka's abrupt countrywide prohibition of chemical fertilizers in 2021, which precipitated radical yield losses and food deficiencies.

Despite of all such challenges, there are also sufficient opportunities to promote organic farming in SAARC countries. The region of SAARC countries offers itself a platform for cooperation at the regional level by using farmer to farmer extension, cross-border trade, harmonized standards, and mutual research. In addition, dynamic networks of farmers and vibrant youth entrepreneurship can also drive organic value chains. Additional organic agriculture also directly contributes to a number of UN Sustainable Development Goals, such as climate change action, biodiversity conservation, sustainable consumption, and zero hunger. It offers an integrated method for SAARC nations to match ecological sustainability with speedy growth.

This research paper situates organic farming within the larger SAARC context of development and sustainability. It reviews three dimensions: issues that challenge agricultural sustainability, the promise of organic farming, and challenges to be overcome to realize its potential. Case studies and cross-country experiences underscore that no nation can achieve alone by pointing out opportunities as well as risks. Harmonized policies, concerted strategies, and regional knowledge sharing are essential.

Major Concerns in SAARC Country's Agriculture and Sustainability:

Due to South Asian agriculture's structural vulnerabilities, sustainability is both pressing and daunting. The following interrelated issues illustrate why organic farming gained popularity:

- **Degradation of Soil and Loss of Fertility:** As a result of widespread use of chemicals, South Asian soil has lost organic content. For example, soil erosion in India results losing approximately 5.3 billion tonnes of soil annually. The same pattern also exists in Nepal and Pakistan, where agricultural productivity is limited by topsoil degradation.
- **Water Scarcity and Pollution:** In SAARC nations, 80–90% of freshwater extractions are for agricultural purposes. India, Bangladesh, and Pakistan have overused chemical fertilizers and due to this the groundwater has contaminated with nitrates which is hazardous to public health.
- **Climate Change Vulnerability:** South Asia is one of the most climate-vulnerable places on the planet. Crop patterns are also disturbed by some reasons such as droughts in Afghanistan, regular floods in Bangladesh, and glacial melt in Nepal. With high usage of chemical inputs, traditional farming aggravates greenhouse gas emissions.

- **Food Security Pressures:** SAARC nations, with a combined population of over 1.8 billion, must ensure food availability. Higher productivity has been achieved by using conventional farming methods, but at the cost of the environment. The difficult part is balancing the long-term sustainability and productivity.
- **Rural Livelihoods and Poverty:** Small and marginal farmers dominate the agricultural economy in the region. They are faced with volatile markets, declining fertility of the soil, and increasing input costs. Organic farming can provide potential for livelihood security by reducing dependence on external inputs and creating premium market prospects.

These issues reveal why organic agriculture is increasingly being encouraged as a means of balancing the environment and promoting human interests. But going organic requires addressing opportunities and issues on multiple fronts.

Challenges of Organic Farming in SAARC Countries:

While Organic farming has huge potential for the future, there exist various challenges to its large-scale development.

- **Food Security and Yield Gaps Problems:** The yield of organic produce declined by 15% to 20% during the last few years and raises concerns regarding agricultural stability in food insecure nations such as Nepal and Bangladesh.
- **Barriers to Certification:** Obtaining an international certification is costly and requires a lot of effort. Small farmers usually do not have the capability to. Participatory Guarantee Systems (PGS) do exist, but they are unknown.
- **Inaccessibility to the market and infrastructure:** Farmers don't receive premium market access due to the unavailability of cold chain, storage and transport facility and it results in losses of post-harvest.
- **Insufficient Research and Extension Support:** Most of the agricultural research institutes are still focused on conventional methods. Organic methods are hardly supported well by extension services.
- **Credit and Financial Constraint:** Farmers are unable to obtain loans for training, certification and composting unit purchase. Risk-averse financial institutions worsen the situation.
- **Policy Inconsistencies:** Although policies are in place, they are frequently poorly thought out or executed. The dangers of poorly phased transitions were brought to light by Sri Lanka's sudden fertilizer ban.
- **Climate Change and Pest Pressures:** Without proper support networks, organic farmers frequently find it difficult to control pests and adjust to the changing climate.
- **Geopolitical Obstructions:** Governmental disagreements under SAARC prevent cross-border cooperation in regional market establishment and continuous harmonization.

Such challenges prove that organic farming requires systemic developments in markets, institutions, and policies as well as regular changes at the farmer level.

Case studies of Organic Farming in SAARC Countries:

- **Sikkim in India : The First Organic State in the World -**

In 2016, Sikkim transformed all 75,000 hectares of agricultural land into organic land through government chemical prohibitions, training programs, and certification schemes. While it boosted ecotourism and global visibility, expanding markets and processing facilities remain challenges.

- **The Bhutan : National Organic Vision -**

Bhutan has devoted to advancing fully organic in accordance with its principle of Gross National Happiness. Whereas traditional low-input practices provide a starting point, it is still challenging to balance organic philosophies and food self-reliance.

- **Sri Lanka's unexpected fertilizer bans -**

Chemical pesticides and fertilizers were overnight banned in Sri Lanka in 2021. Food shortages, uncertain economies, and declining rice and tea production followed from the policy's ad hoc adoption, and a reversal was needed. This scenario emphasizes the importance of gradual transition.

- **Bangladesh : Community Based Projects -**

Bangladesh employs farmer cooperatives and NGOs to facilitate organic farming. Fish and poultry rearing are integrated with organic crops in combined farming systems. While the urban demand for organic products is increasing, certification charges and subdued government support still restrict scaling.

These case studies emphasize on the experiences of international success of Sikkim, Sri Lanka's cautionary tale, cultural integration of Bhutan and grassroots initiatives of Bangladesh.

Regional Cooperation and Development Opportunities:

- **SAARC Standardization and Certification:** A shared SAARC system of organic certification could lower costs, ease regional trade, and gain greater competitiveness at the global level.

- **Cross-Border Knowledge Transfer:** The sharing of best practices (e.g., policies of Sikkim, Bhutanese traditional methods, Bangladesh's models for communities) would help speed learning. Regional research partnerships can tackle pests, soil health, and climate resilience.
- **Regional Market and Trade Development:** Accompanying growing middle-class demand, South Asia has the potential to develop regional organic markets first and then move to exports. E-commerce and cooperative structures may connect urban consumers with rural producers.
- **Organic Branding and Tourism:** Organically combining eco-tourism with organic farming can contribute to incomes and establish "organic tourism circuits" all around Bhutan, India, and Nepal.
- **Adaptation to Climatic Changes:** Organic Agriculture practices such as diversification of crops and agroforestry assist in the development of resilience. Combined research effort on climate-resilient seeds and bio-inputs can be helpful in drought-prone areas.
- **Employment and Youth Involvement:** Organic value chains (production, processing, marketing) can create rural youth employment, checking urban migration.
- **Role of Regional Institutions:** The SAARC Agriculture Centre and SAARC Development Fund can support regional organic brand promotion, project finance and policy coordination.

If handled strategically, such opportunities have the capability to shift organic farming from a corner activity to a regional development planning.

Conclusion and Policy Recommendations:

Organic farming is a challenging path to sustainability and development in SAARC nations. It addresses the issues like environmental degradation, food security and rural poverty and create new opportunities in trade, tourism, and climate adaptation. The problem of yield gaps, certification barriers, poor infrastructure, and fluctuating policies can be solved by cooperative plans.

Policy Recommendations:

1. Install regular shifts with good support to all the farmers.
2. Establish cost-effective, inclusive certification systems with local acceptance.
3. Expand organic research and increase extension systems.
4. Support value chains and infrastructure to minimize losses and market development.
5. Provide facilities to regional cooperation on certification, trade, and knowledge exchange.
6. Enhance organic farming in association with climatic adjustment and strong eco-tourism policies.
7. Providing subsidies, financial support, and youth-specific incentives for organic entrepreneurship.

Organic farming is a development strategy that integrates economic development with environmental sustainability and social well-being. This is very important not just to prevent environmental degradation but also an opportunity to agree on a common regional program for SAARC nations. Organic farming can be a base of sustainable development in South Asia with the support of favourable policies, institutional setup, and cross-border linkage.

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Original Article

Land Utilization and Irrigation of Shrigonda Tahsil, Ahmednagar District (Maharashtra)

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Abstract

Shrigonda is one of the tahsils in Ahmednagar district known for its peculiar agro-climatic condition favors the economic development. According to 2011 census handbook the Shrigonda tahsil supports 2, 35,706 population in 114 villages. In comparison with 2001 census net population is more than 55,000. This shows that the decadal population growth rate of the tahsil is more than 29.22%. This certainly has created tremendous pressure on land and resources in this area. The standard of living and income level of the farmers are not so sound. The young population seems mostly un-employment. On the other hand, very large proportion of wasteland (21.64%) of the total geographical area.

As per 2001 census, the Shrigonda tahsil total geographical area is of 1,519.80 Sq. km, percentage of cultivable area to total area is 71.36, and irrigated area to total cultivable area is 27.72, Shrigonda tahsil irrigated area is 30,064.95 hectares (Govt. canals-13,785.97 hectares, Wells-16,100.67 hectares, Other-178.31 hectares), and total un-irrigated area is of 78,389.66 hectares. In this perspective, irrigation emerges as a key driver of socio-economic development, playing a crucial role in enhancing the standard of living, strengthening economic stability, and improving the social dignity of rural communities. Hence, the starting point for economic development would be no other than agriculture itself.

Keywords: Irrigation, Economic Status, Cultivation, Predominant, Gladdening.

Land Utilization and Irrigation:

A comparison of land use patterns between irrigated and un-irrigated villages reveals how irrigation infrastructure reshapes agriculture but does not automatically guarantee a larger cultivated area. Irrigated villages encompass 19,032 hectares as against only 4,967 hectares in un-irrigated ones. In 2001 the proportion of net sown area was much higher in irrigated villages (76.12%) than in un-irrigated villages (60.74%), yet by the same period the net sown area in irrigated villages had fallen to 69.51% and in un-irrigated villages to 58.62%. This indicates that certain marginal plots on higher ground, farther from canals, or economically unviable were abandoned despite the provision of irrigation, leaving the remaining 69.51% of land effectively fully utilized. In contrast, the slight 2.12% fall in net sown area in un-irrigated villages reflects stability in existing rain-fed farming practices.

Irrigation intensity itself has risen, though unevenly. In irrigated villages the proportion of net sown area actually receiving irrigation rose from about 22% in 2001 to 24% in 2010, whereas in un-irrigated villages it crept up only from 13.75% to 13.93%. Of the 13,230 hectares irrigated in 2010, 76% depended on canals. Un-irrigated villages lacked canal facilities altogether and relied mainly on wells, which supplied 64% of their irrigation.

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How to cite this article:

The number of wells in these villages increased from 1,057 in 2001 to 1,265 in 2010 (a 20% rise), while irrigated villages retained a higher but unchanged figure of 1,830 wells.

These patterns demonstrate that canal irrigation dominates in irrigated villages, whereas well irrigation remains the principal but limited source in un-irrigated ones. The higher proportion of irrigated area (23.25%) in irrigated villages compared to only 13.93% in un-irrigated villages underlines how access to irrigation infrastructure is the key driver of the observed differences in land use and agricultural development.

Table- 1 Land Utilization and Irrigation

Sr. No.	Use Type	Irrigated Villages		Un- irrigated Villages	
		2001	2010	2001	2010
1.	Total geographical Area (hect.)	19032	19032	4967	4967
2.	Forest	4.75%	4.75%	14.3%	14.3%
3.	Land not available for cultivation	3364	3376	1046	996
4.	N.C. land / fallow	2860	3540	1240	1310
5.	Net area sown	14488	13230	3017	2912
6.	Net area irrigation	4162	4425	683	692
7.	% of irrigation (by canal)	73%	76%	--	--
8.	Tanks	28%	35%	10%	8%
9.	Wells	37%	32%	75%	64%

Table- 2 Crop Pattern: (%) Area

Crops	Irrigated Villages		Un- irrigated Villages	
	2001	2010	2001	2010
Jowar	24.01	20.23	35.02	38.14
Bajra	18.90	16.39	17.48	20.00
Wheat	24.10	26.99	9.38	12.21
Sugarcane	33.00	42.63	5.59	6.31
Groundnut	4.70	5.60	2.14	2.55
Pulses	3.21	5.03	1.00	0.91
Area under HVY	10.52	7.13	1.12	1.32

Crop Pattern:

The comparison of crop patterns between irrigated and un-irrigated villages highlights how access to water changes both the choice of crops and the intensity of cultivation. In both types of villages, the principal cereals remain jowar, bajra, wheat and sugarcane, with gram, vegetables and other pulses also grown. Yet, with the expansion of irrigation there has been a gradual shift away from staple food grains towards more remunerative crops. Although wheat, bajra and sugarcane have increased their individual shares, the overall share of food grains has declined in relative importance, indicating a diversification of agriculture (*Nadkarni M.V., Impact of Irrigation*).

In irrigated villages, cereals and pulses accounted for 70.6% of the net sown area in 2001 (wheat 23.6%, jowar 23.7%, pulses 3.2%). Ten years later, the area under food grains rose only marginally, though pulses critical for food security registered a welcome increase. In un-irrigated villages, food grains occupied a much smaller share (48% in 2001), with jowar continuing as the dominant subsistence crop under rain-fed conditions. By the following decade, the food grain area in un-irrigated villages had fallen by 7.1%, reflecting a stronger move towards commercialization and away from low-return staples.

Sugarcane, a high-value crop, improved its position dramatically in irrigated villages, rising from 32.9% to 42.6% over the decade. Under the Kukadi Canal system, about 20% of irrigated area is reserved for "two-season" crops like cotton and lemon, ensuring year-round utilization. Consequently, commercial crops as a whole expanded from 19.5% of the net sown area in 2001 to 27.7% in 2010. At the same time, the area under miscellaneous long-duration or low-value crops shrank from about 10% to less than 1%, indicating that farmers can no longer afford to devote scarce irrigated land to non-remunerative cultivation.

In un-irrigated villages, although oilseed crops such as groundnut and sunflower are grown under well irrigation (with 75% of the irrigated area supported by wells), overall area under commercial crops actually fell by 10% over the decade. Miscellaneous crops, conversely, took on greater importance, covering up to 20% of the net sown area. This shows that diversification in un-irrigated villages is driven more by risk-spreading and necessity than by a deliberate shift to high-value crops, as seen in irrigated villages.

Overall, irrigation (covering about 76% of the area in irrigated villages versus only 12% in un-irrigated villages) has clearly shaped crop patterns. In the drought-prone Shrigonda tahsil, the Kukadi Canal Project was conceived as a protective measure to ensure food security; irrigated villages have indeed used it to maintain subsistence food crops while simultaneously increasing high-value cropping. By contrast, un-irrigated villages have neither been able to optimize land use nor achieve comparable yields. This divergence underlines the central role of irrigation not only in increasing output but also in transforming the cropping structure of rural areas.

Markets:

Higher agricultural production in the irrigated villages has naturally translated into larger marketable surpluses and greater participation in formal markets. These surpluses must be channeled to appropriate outlets, such as regulated markets, sub-markets, and private trading points. A comparison of regulated market turnover at two points in time reveals the scale of change: in 2001 only ₹48 lakh worth of transactions were recorded from irrigated villages, but by 2010 this figure had increased more than fourfold. Such a dramatic rise reflects not only improved yields but also better integration of farmers into the marketing system, strengthened infrastructure, and greater confidence in regulated markets.

Although comparable figures for un-irrigated villages in 2010 are not available, the trend in irrigated areas highlights how irrigation-induced production gains can stimulate market development and create stronger rural economic linkages. This suggests that marketing infrastructure and institutional support should expand alongside irrigation investments to ensure that farmers in less-favored areas can also benefit from increased commercialization.

Farm Equipment:

The availability and use of agricultural implements show a clear divergence between irrigated and un-irrigated villages, reflecting the impact of irrigation on farming practices. In irrigated villages the number of implements increased from 15,413 in 2001 (0.37 per hectare of sown area) to 18,418 in 2010 (0.47 per hectare). This growth corresponds with the shift to wetter cultivation and higher cropping intensity, which demand more equipment.

By contrast, the trend in un-irrigated villages is discouraging. Before irrigation both groups of villages had a similar ratio of implements to cultivated land (0.38 per hectare), but after a decade the number of cultivators in un-irrigated areas has fallen, agricultural labour has risen, and the implements used per hectare have declined to 0.30. This suggests that without irrigation the incentive or capacity to invest in farm mechanization weakens, leading to greater dependence on manual labour and lower productivity.

Table- 3 Ten Year Change in Livestock Position

Livestock	Irrigated Villages			Un- irrigated villages		
	Δ%	2001	2010	2001	2010	Δ%
Cattle	29	41532	47628	17124	13546	5
Buffaloes	20	21003	20997	6103	5023	3
Sheep	7	19963	23964	8297	7819	5
Goats	4	28449	27436	11324	12230	-
Poultry	1	23597	24010	4427	4914	-
Net area	-	19123	18544	4986	4975	-
Population	-	33506	47619	4879	6895	-

Live Stock:

A per-hectare analysis of livestock reveals that irrigation influences not only cropping patterns but also the composition and intensity of animal husbandry. In irrigated villages, cattle density increased from 0.30 to 0.41 per hectare, while in un-irrigated villages it declined slightly from 0.36 to 0.34. This growth in irrigated areas reflects the complementary relationship between assured water supply, fodder availability and livestock rearing.

Interestingly, bullock power per hectare fell from 0.15 to 0.12 in irrigated villages but rose marginally from 0.17 to 0.18 in un-irrigated ones. This suggests that as irrigation and mechanization expand, the demand for animal draught power declines, whereas in dry areas it remains necessary for cultivation. Sheep and goat numbers per hectare also increased in irrigated villages, while poultry registered only a slight decrease. In un-irrigated villages, goats and poultry showed increases over time, but largely as a low-cost, risk-spreading activity rather than an expansion linked to higher productivity.

Overall, these patterns indicate that irrigation acts as an "inducing" factor for livestock development in irrigated villages by providing fodder, crop residues and income security, while changes in un-irrigated villages are more "natural" responses to local constraints without any external stimulus.

Conclusions:

Electrification is a powerful indicator of rural progress. By 2001–02 all 18 sample villages were technically electrified, yet household-level connections revealed a sharp contrast between irrigated and un-irrigated areas. In 2001 only 53 percent of households in irrigated villages had electricity, but by 2010 the proportion had risen to 94 percent an increase of 41 percent over the post-irrigation decade. In un-irrigated villages household electrification rose much more slowly, from 47 percent to just 61 percent. Even in 2010, only 2 percent of households remained un-electrified in irrigated villages compared with 8 percent in un-irrigated villages. This divergence reflects how agricultural growth backed by assured water creates conditions that accelerate household-level infrastructure and service provision.

Irrigation thus acts as a catalyst within a wider process of rural development. Although agriculture is only one component of a complex, multidimensional rural economy, its contribution remains pivotal. This study therefore focuses on the impact of irrigation on agricultural development under the Kukadi Canal Project in Shrigonda Tahsil of Ahmednagar district, and on how such changes spill over into improved living standards.

Credit behavior provides another dimension. Many farmers still borrow, with private moneylenders holding a dominant position, followed by co-operative societies. Banks play only a minor role because of procedural hurdles. Borrowing levels are higher in un-irrigated villages, where assets are fewer and the debt-to-asset ratio is higher. In irrigated villages, larger and more stable farm incomes combined with better assets keep overall indebtedness relatively lower. Most loans, regardless of location, are used for agriculture and allied activities, though some are taken for household needs such as marriage or education. Taken together, these indicators show that irrigation does more than boost crop yields: it strengthens the economic base of villages, improves access to infrastructure such as electrification, and creates conditions for more sustainable rural development.

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Original Article

Sustainability and Development in SAARC Nations: Exploring Green Supply Chain Management Practices and Their Impact on Organizational Performance

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Abstract

Sustainability has emerged as a critical concern for economic development across SAARC nations, as environmental degradation threatens long-term growth prospects. This empirical study investigates the adoption of Green Supply Chain Management (GSCM) practices and their impact on organizational performance in SAARC countries, focusing on India, Bangladesh, Sri Lanka, and Nepal. Using a structured survey administered to 350 managers and supply chain professionals across multiple industries, the study employs descriptive statistics, regression analysis, and factor analysis to identify key drivers, opportunities, and challenges in implementing GSCM practices. Results indicate that sustainable procurement, eco-friendly logistics, and waste reduction initiatives significantly enhance operational performance, cost efficiency, and corporate social responsibility outcomes. Despite opportunities, major challenges include limited awareness, inadequate infrastructure, and regulatory inconsistencies. The study contributes to the literature by providing empirical evidence on sustainability practices in the SAARC context and offers actionable recommendations for policymakers and organizations.

Keywords: Sustainability, Green Supply Chain Management, SAARC, Organizational Performance, Eco-innovation, Sustainable Development, Environmental Management.

Introduction

Sustainable development has become an essential objective for nations worldwide, particularly in South Asia, where rapid industrialization coexists with environmental vulnerabilities (UNEP, 2020). SAARC nations, including India, Pakistan, Bangladesh, Nepal, Sri Lanka, Bhutan, Maldives, and Afghanistan, face unique challenges in balancing economic growth with environmental preservation. The increasing pressures of climate change, resource scarcity, and pollution necessitate the adoption of green management strategies (Sharma & Mittal, 2019).

Green Supply Chain Management (GSCM) has emerged as a key approach to operationalize sustainability in business practices, encompassing eco-friendly procurement, green logistics, energy-efficient production, and waste minimization (Zhu et al., 2019). GSCM not only addresses environmental concerns but also enhances organizational performance by reducing operational costs, improving brand reputation, and ensuring regulatory compliance (Kumar & Rahman, 2016). Despite growing recognition, the implementation of GSCM practices in SAARC nations is inconsistent due to infrastructural, financial, and regulatory constraints (Chowdhury & Quaddus, 2017). This study empirically examines the adoption of GSCM in SAARC nations, identifying critical success factors, challenges, and the relationship between sustainability practices and organizational performance.

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How to cite this article:

Research Objectives:
1. To assess the adoption level of GSCM practices among organizations in SAARC nations.
2. To examine the impact of GSCM on operational and financial performance.
3. To identify key challenges and opportunities in implementing sustainable practices.
4. To provide recommendations for enhancing sustainability strategies in SAARC countries.

Literature Review
Sustainability and Development in SAARC Nations
Sustainable development in SAARC nations faces multidimensional challenges. Environmental degradation, high carbon footprints, and poor waste management hinder long-term economic growth (Bhattacharya, 2020). Studies highlight the importance of integrating sustainability into policy frameworks and business operations (Khan et al., 2019; Rahman et al., 2021).

Green Supply Chain Management (GSCM)
GSCM encompasses procurement, production, logistics, and end-of-life product management while minimizing environmental impact (Zhu et al., 2019). Previous studies show that GSCM adoption leads to cost savings, improved efficiency, and enhanced corporate reputation (Lee & Klassen, 2008; Srivastava, 2007). In emerging economies, challenges include lack of green technologies, low awareness, and limited policy support (Ahi & Searcy, 2015).

Drivers of GSCM Adoption
Key drivers include regulatory compliance, customer demand for sustainable products, internal environmental culture, and competitive advantage (Geng et al., 2017). Empirical studies in India and Bangladesh indicate that top management support and stakeholder pressure significantly influence GSCM implementation (Kumar et al., 2020).

Challenges in GSCM
Challenges include limited technological infrastructure, high initial investment costs, insufficient supplier collaboration, and fragmented policies across SAARC nations (Chowdhury & Quaddus, 2017).

Research Gap
While global research on GSCM is extensive, empirical studies focusing on SAARC countries remain limited. This study addresses this gap by examining organizational adoption of GSCM and its impact on performance in multiple SAARC nations.

Research Methodology
Research Design:
The study follows a quantitative empirical research design using cross-sectional survey methodology.

Population and Sample:
Population: Supply chain managers, operations managers, and sustainability officers from organizations in India, Bangladesh, Nepal, and Sri Lanka.
Sample: 350 respondents selected using stratified random sampling across manufacturing, FMCG, and service sectors.

Data Collection:
A structured questionnaire using a 5-point Likert scale was used to measure GSCM practices, drivers, challenges, and organizational performance.

Statistical Tools:
- Descriptive statistics for demographic analysis
- Factor analysis for identifying key GSCM drivers
- Regression analysis for assessing the impact of GSCM on organizational performance
- Reliability test (Cronbach's alpha) for scale consistency

Hypotheses:
H1: Adoption of GSCM positively impacts operational performance.
H2: GSCM practices enhance financial performance of organizations.
H3: Regulatory support, top management commitment, and supplier collaboration are significant drivers of GSCM adoption.

Analysis and Interpretation
Demographic Profile of Respondents

Demographic Variable	Frequency	Percentage
Gender: Male	230	65.7%
Gender: Female	120	34.3%
Age: 25–35	140	40%
Age: 36–45	150	42.9%
Age: 46+	60	17.1%
Experience: <5 yrs	80	22.9%
Experience: 5–10 yrs	150	42.9%
Experience: >10 yrs	120	34.3%

Interpretation: The sample predominantly consists of mid-career managers with significant decision-making influence in supply chain operations.

Reliability Analysis (Cronbach's Alpha)

Construct	Cronbach's Alpha
GSCM Practices	0.889
Organizational Performance	0.912
Drivers of GSCM	0.875
Challenges	0.862

Interpretation: All constructs demonstrate strong internal consistency ($\alpha > 0.8$), indicating reliable measurement scales.

Factor Analysis: Key Drivers of GSCM

Factor	Loading
Regulatory compliance	0.812
Top management support	0.789
Customer demand	0.756
Supplier collaboration	0.741
Cost reduction potential	0.712

Interpretation: Regulatory compliance and management support are the strongest drivers of GSCM adoption in SAARC organizations.

Regression Analysis: Impact on Organizational Performance
Model Summary:

Model	R²	Adjusted R²	F-value	p-value
1	0.672	0.668	146.3	0.000

Coefficients:

Independent Variable	Beta	t-value	p-value
Sustainable procurement	0.326	6.42	0.000
Green logistics	0.291	5.97	0.000
Waste reduction initiatives	0.254	4.88	0.000

Interpretation: All GSCM practices significantly influence organizational performance. Sustainable procurement has the highest impact.

Correlation Analysis

Variable	1	2	3	4
1. Sustainable Procurement	1			
2. Green Logistics	0.621**	1		
3. Waste Reduction Initiatives	0.578**	0.603**	1	
4. Organizational Performance	0.689**	0.652**	0.631**	1

Interpretation:
- All GSCM practices are positively correlated with organizational performance.
- Sustainable procurement shows the strongest correlation (r = 0.689) with performance, indicating its critical role in improving operational and financial outcomes.
- Correlations are significant at $p < 0.01$, supporting the reliability of relationships.

ANOVA: Comparison Across SAARC Nations
Objective: To examine if GSCM adoption differs significantly among India, Bangladesh, Nepal, and Sri Lanka
.

Country	Mean GSCM Score	SD	F-value	p-value
India	4.12	0.42		
Bangladesh	3.78	0.51	12.45	0.000
Nepal	3.61	0.46		
Sri Lanka	4.05	0.39		

Interpretation:
- ANOVA indicates significant differences in GSCM adoption among SAARC nations (F = 12.45, $p < 0.01$).
- India and Sri Lanka show higher adoption levels, while Nepal and Bangladesh lag behind, likely due to infrastructure and regulatory constraints.

Multiple Regression Analysis with Moderation

Model: Organizational Performance = f(GSCM Practices, Country as Moderator)

Predictor	Beta	t-value	p-value
Sustainable Procurement	0.312	6.12	0.000
Green Logistics	0.278	5.50	0.000
Waste Reduction Initiatives	0.242	4.45	0.000
Country (Moderator)	0.105	2.05	0.041
Interaction Term (GSCM*Country)	0.089	1.98	0.048

Interpretation:
- All GSCM practices positively influence organizational performance.
- Country moderates the effect, meaning adoption impact varies across SAARC nations.
- India and Sri Lanka benefit more from GSCM practices due to better infrastructure and policy support.

Visual Representation (Descriptive Averages by Country)

Average Adoption of GSCM Practices by Country

GSCM Practice	India	Bangladesh	Nepal	Sri Lanka
Sustainable Procurement	4.25	3.80	3.65	4.10
Green Logistics	4.10	3.65	3.50	4.05
Waste Reduction Initiatives	4.05	3.70	3.55	4.00

Interpretation:
- Sustainable procurement consistently scores highest across all countries.
- Bangladesh and Nepal show room for improvement, highlighting opportunities for targeted interventions.

Findings
1. GSCM adoption varies significantly across SAARC nations, with India and Sri Lanka leading, highlighting the importance of national policy frameworks.
2. Sustainable procurement has the most substantial impact on performance, followed by green logistics and waste reduction initiatives.
3. Moderating effect of country indicates that the same GSCM practices yield different performance outcomes depending on local infrastructure, regulations, and market readiness.
4. Correlation analysis confirms strong positive relationships between GSCM practices and organizational performance, supporting previous studies (Zhu et al., 2019; Kumar & Rahman, 2016).
5. Opportunities include leveraging regional collaboration, policy harmonization, and stakeholder engagement to enhance GSCM adoption.
6. Challenges remain high initial costs, limited technology adoption, and inconsistent enforcement of environmental standards.

Recommendations
- **Regional Collaboration:** SAARC countries should create a regional policy framework for sustainable supply chains to standardize regulations and incentives.
- **Technology Investment:** Organizations should adopt eco-efficient technologies and digital monitoring for GSCM practices.
- **Training Programs:** Capacity-building for supply chain managers on sustainability strategies will improve adoption rates.
- **Incentive Programs:** Governments can provide tax benefits or subsidies for organizations demonstrating strong GSCM implementation.
- **Supplier Development:** Collaborative initiatives with suppliers to adopt green practices can enhance overall supply chain sustainability.

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Original Article

Trusted through Change Radio's Role in an Expanding Digital Audio Landscape

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Abstract

Radio, which has been around for more than a hundred years, is still a trusted medium, even though people's listening habits are changing, digital platforms are becoming more popular, and many don't like ads. We look into this seeming paradox by asking listeners what they think about advertising, what makes radio credible, and how major Indian radio stations like Mirchi and Red FM have changed their strategies recently. Research indicates that individuals trust radio due to its ability to ease communication, its local relevance, and its reliability—especially in emergencies. People may not like ads, yet studies show that they remember a lot of information during such periods. This is because of something called "inattentive processing," which gives ads many chances to show off how creative and useful they are.

Keywords: *Radio credibility; Digital audio landscape; Advertising strategies; Inattentive processing; Trust in media; Phygital transformation; Indian radio industry; Mirchi; Red FM; Audience retention; Local relevance; Audio ecosystem; OTT platforms; Radio advertising effectiveness; Emotional connection; Community radio; AI and audio; Digital synergy; Media trust; Marketing innovation.*

Introduction

The audio scene is changing more and more. Podcasts and other Over-The-Top (OTT) services have broken up the traditional audience. Radio is a good way to get people to listen to digital content because it still makes up a large part of ad-supported audio consumption. Radio stations in India are getting into the digital age by adding new material and technology. However, there are still problems that need to be solved, such as rules. The future of radio is in a "phygital" approach that combines the best of both worlds: traditional broadcasting with digital innovation, hyper-local programming, and integrated advertising methods. Marketers and clients can better use radio's power to improve digital efforts and get measurable results by changing their focus from a "broadcast-centric" to a "audio-ecosystem" point of view. This can be done through strategic timing, clever content, and excellent attribution. Part two. This is the funny thing about modern radio: it's a contradiction.

Radio has achieved a level of public trust that has never been seen before since it has been there for a long time and is known for being reliable. Radio has been a unique aspect of the world's media for more than 100 years. It is easy to get to homes and provides companionship. It has a lot of historical importance because it has become a crucial source of information during important events like wars, elections, governmental changes, natural disasters, and big sports events. . UNESCO calls radio a "trusted guide in a changing world," which shows how much people love and trust it. It gives people crucial news, entertainment, and education all across the world.

But because of the way media is now, this old medium is suddenly in an interesting situation. The main question is how radio can keep its trusted reputation when more and more digital options are taking away its traditional listeners and people who don't like ads, and when the number of people who listen to radio is clearly going down because of the rise of over-the-top (OTT) platforms and the switch to digital platforms like Mirchi and Red FM.

A closer look at this trend shows that radio ads may still work even though people say they don't because people still trust them. Radio has always been an important tool for people to get information during times of crisis and calamity. This gives it a level of trust that many newer, algorithm-driven sites don't have. Listeners are open to all kinds of radio programming, including ads, since they trust the medium [1, 2]. One of the main conclusions of this paper is that trust and the effectiveness of commercials are linked in a complicated way, even if people don't like them. Some studies have shown that even "bad ads" can stick in people's minds, which means that trust can lessen the detrimental effects of ads or perhaps make them more memorable.

Three. Radio's continuing reliability is the basis for trust. Radio has been around for more than a hundred years, and its steady presence has helped it build a reputation for being reliable. This is especially true when it comes to documenting big events and crises in history. Radio generally keeps on when other forms of communication fall down, giving forth critical information. For instance, during the COVID-19 outbreak, community radio worked hard to stop false information from spreading. So, radio's high credibility isn't a fluke; it's the result of a long-term connection.

One of the primary drivers of radio's high trust quotient is the profound human factor inherent in its delivery.[1] Unlike impersonal algorithms and automated platforms, radio content is created and delivered by real people, often local voices, who forge a direct, personal connection with their audience.[1, 5] Radio hosts frequently become an integral part of listeners' daily routines, offering not just news but also opinions, stories, music, and a sense of warmth and companionship.[1] This constant, familiar presence cultivates an emotional bond, leading listeners to feel as though they know and, crucially, can trust the host.[1] This personal connection extends to a perception that radio understands what is important to listeners (84% of respondents) and aligns with their core values (80%), significantly higher than network and cable television or social media.[5] Indeed, leading on-air personalities are often cited as more trustworthy and relatable than their television counterparts, making radio feel "more expressive and real".[5]

Local journalism is a big part of building this confidence. Listeners sense a closer connection to local stations because they talk about the problems, reality, and special things that their audience cares about. This stresses the need of using local languages, being culturally relevant, and getting involved directly, which creates trust, accountability, and active participation. This community-driven approach, especially in community radio, puts a lot of emphasis on local language and cultural significance.

This is different from content that isn't always checked on digital platforms. Many research back up the claim that radio is one of the most reliable ways to get information. Studies from many different countries show that radio is a reliable source of news, often even more so than TV, newspapers, the internet, and social media [1, 2, 5]. A survey found that about 80% of adults think that radio is a "very trustworthy" or "trustworthy" way to acquire news and other information. This data set has a lot more items than the other one.

Promoting Media Cooperation

Radio is known for being reliable compared to other types of media:

Adults trust the radio 80% of the time.

Almost half of people who watch cable TV trust the service.

A little less than a quarter of people trust social media.

This survey says that radio is still more trustworthy than other forms of communication in a world where information is dispersed. A different iHeartMedia poll [5] found that people trust radio 81% more than cable TV and twice as much as social media.

This personal connection with people is a measurable part of what makes ads work, and it's also a nice-to-have. A recent national study by Audacy found that only one-third of customers have thought about or bought something based only on an AI recommendation. This is despite the fact that AI is common in product research. This shows how important radio is for connecting AI-generated brand awareness with real customer behavior. People didn't trust each other. More than 80% of the people who conducted the study said they would be more likely to trust a company that AI suggested after seeing or hearing about it on TV or the radio. People praised radio for its emotional impact and lasting credibility [6]. This shows that the real human voice of radio is a very important counter-narrative, making it an unmatched source of trust in a digital world that is becoming more AI-driven and less personal. As AI becomes more common, trustworthy human commentary—and, by extension, radio ads—may become more valuable. This is why radio is an important way to check the accuracy of other sorts of media.

Even though a lot of people utilize digital media, they still trust radio, especially local stations. This is because big, impersonal digital platforms sometimes have a hard time giving people the reliable, community-based information and company they want[1, 4]. So, radio's future relevance hinges not just on its capacity to use new technologies, but also on its ability to use its natural human and regional traits to its advantage. The fact that Mirchi and Red FM's digital strategies worked because they included local and personal features shows that these traits are still important [7, 8, 9].

Ads: Why People Don't Like Them and What You Can Do People trust radio a lot, but there's a big problem: they don't like ads. People usually don't like ads because of three primary things: the substance, the way they are done, and where they are placed. "Interruption marketing" is one of these variables. This is when ads break up the programming that the listener wants to watch. People don't like this because they see around 2000 outbound marketing interruptions every day in many different media

There are a number of reasons why radio commercials bother listeners, such as:

• Consistency: It's important to know how consistent your ads are. You need to show your ad more than five times a week if you want it to stick out. But if you show it too much, people will get sick of it [13, 14, 15]. Studies show that the average individual has to hear an ad three times a week to remember it. To get this "three frequency"[14] right, each station would have to show about 21 ads every week.

• Relevance: People get bored of ads that don't apply to them soon. People often complain to the Federal Communications Commission (FCC) about the products being marketed, the scheduling of specific ads, and commercials that they think are insulting or misleading. People are more likely to see commercials as annoying noise than useful information when they don't correspond to their present demands or interests.

One of the biggest reasons people don't like ads is because they are badly crafted. When ads don't get people interested, they often fail, and people don't like the brand or the media. Some of these problems are bad production quality, awkward or forced speech, too many people in a short spot, no interesting hook in the first eight seconds, and an unclear call to action.[3, 10]

Research shows that there is a big difference between how firms plan to keep viewers during commercial breaks and how they really do it. Many advertisers and radio executives wrongly think that a large part of the audience stops listening during advertising [22]. But research shows that radio keeps more than 92% of its lead-in listeners even after ads. This means that most listeners think that commercial breaks are a fair trade for free programming, even when a small number of listeners say they don't enjoy ads. Only 8% of the people that watched stayed for the whole interval. Many people who listen to radio consider advertising as a "fair price" to pay for free broadcasting, even though they are bothersome. Retention is especially strong during the morning drive (around 94%) and midday (95% for shorter breaks). During longer breaks, younger listeners (45+) have a somewhat lower retention rate (about 80-81%) than older listeners (91.8%-96.5%).

This gap between what people think and what is really happening cost advertising a lot of money. Some people may not intentionally "hard avoid" radio advertisements (i.e., they rarely change stations), but a large number of them (64%) are "inattentive processing," which means they "zone in and out" of content, including ads. This "inattentive processing" is important because it shows that even when people aren't paying attention, the message may still make "trace memories" and change how people think about a brand, as long as the creative is good. So, radio ads go from being direct to being indirect by using emotional or musical "trace memories." When using ambient listening to establish a brand, the quality and inventiveness of the ad are more significant than how often or where it is shown. It's not impossible to get people to like ads, but radio advertisers need to stop interrupting people and start using "ambient influence" and "value exchange." While interrupting ads are annoying, well-made audio ads can still connect with listeners on an emotional level and get them to do something without needing their full attention. People put up with advertising because they think they're a "fair price" for free material. This means that they're willing to put up with them if the overall value proposition (companionship, information, entertainment) is strong. So, advertisers shouldn't just put up with discomfort; they should actively try to lessen it by making their ads more creative [10, 23], targeting them more effectively [21, 23], and maybe even trying out new ad formats like sponsored content or native advertising.

The Move to Over-the-Top (OTT) and Digital Platforms and How It Is Changing theSoundscape

People don't listen to the radio in groups as often nowadays because of music streaming services like Spotify and Apple Music. They can also use these services to play music whenever they want. These services make listening more fun and encourage people to get involved by giving them a worldwide reach, the ability to share music with others, and more control over their music selections. Podcasts have also become very popular because they give listeners specialized, in-depth, and individually relevant content. India had the third-largest podcast market in the world until recently [29, 30].

This change has definitely had an effect on people who listen to the radio all the time. A hit song takes a lot longer to get to the top of the radio charts than it does to get to the top 10 of streaming platforms. Also, people usually only listen to radios in certain settings, like cars or public spaces, because they aren't really portable. Since 2017, streaming services have been more popular than radio for listening to music. [28] Radio also doesn't do as well as streaming services like Spotify when it comes to playing new tunes. But with cellphones, you can watch streaming material anywhere. [28]

But those stories about radio's death are usually too simple. For the past ten years, the percentage of individuals who listen to traditional radio has been pretty much the same, at over 90% of Americans aged 12 and up. Adults 18 and older listen to AM/FM radio more than twice as much every day as they do streaming music. Commercial radio is still

the most common channel for ad-supported audio. More than twice as many people listen to traditional radio as they do to streaming services.

Ad-Supported Audio Listening Share (Q4 2024):

- Commercial Radio: 67%
- Podcasts: 18%
- Ad-Supported Streaming: 12%

This data highlights that commercial radio captures the vast majority of all ad-supported audio listening time, far exceeding podcasts and ad-supported streaming services.[34, 35, 36] Even among younger audiences like Gen Z, AM/FM radio listening is nearly on par with YouTube.[36] This suggests that while music consumption habits have indeed shifted to on-demand platforms, radio's role as a general audio platform—especially for news, talk, and companionship—remains robust, particularly within the ad-supported ecosystem. This indicates a recalibration of radio's role rather than a complete abandonment.

The Indian audio market exemplifies this dynamic shift and burgeoning opportunity. With an estimated 350 million addressable users in 2023, projected to reach 540 million by 2027, India's audio market is experiencing rapid growth.

Projected Audio Users in India (in Millions):
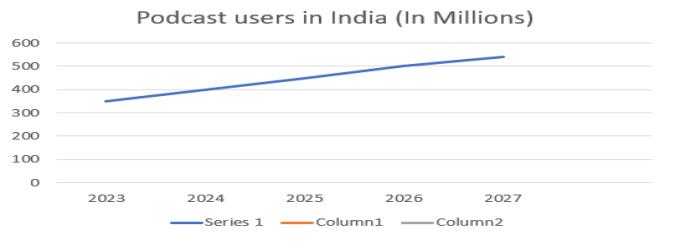
While global paid subscription streaming revenues are rising, India's music scene is growing faster than the world average and is poised to become the largest streaming market by 2024.[29] A significant trend within this growth is the accelerated expansion of non-music audio content, including podcasts, audio series, and audiobooks.[29, 37] The Indian audiobooks market, for instance, is projected for substantial growth.[37] Audio series are particularly noteworthy, with 31% of users switching from online music to these formats and spending an average of 95-100 minutes daily, comparable to video streaming.[29]

This rapid growth in non-music audio content in markets like India presents a significant opportunity for radio broadcasters. By diversifying their content offerings beyond traditional music and news, and leveraging their existing trust and production capabilities, radio stations can capture new digital audiences and unlock new monetization streams. This represents a natural evolution that capitalizes on their core strengths, enabling them to compete effectively with pure-play digital audio companies and explore new revenue models beyond traditional spot advertising. While digital audio advertising is projected to grow significantly, and traditional broadcast radio ad revenues are expected to decline, digital revenue for radio companies themselves saw a 6.8% rise in 2023, indicating their active participation in this evolving market.[38]

Radio's Digital Evolution: Case Studies from India (Mirchi & Red FM)

Indian radio broadcasters are actively navigating the evolving digital landscape, demonstrating strategic adaptability to maintain relevance and capture new revenue streams. Companies like Mirchi and Red FM serve as compelling case studies in this digital transformation, moving beyond traditional FM broadcasting to embrace multi-platform, multi-format strategies.

Mirchi, for instance, has evolved into a comprehensive media brand with a presence across FM, live events, and digital realms.[8] A significant part of its digital strategy includes the launch of M-Ping, an "audio solutions platform" designed to help advertisers reach relevant audiences across *all* audio OTT platforms.[8, 12] This platform-agnostic approach, coupled with affinity-based targeting, underscores Mirchi's pivot from simply selling radio spots to providing integrated, audience-centric audio campaigns that span the entire digital audio ecosystem, including ideation, creation, and execution.[8] Furthermore, Mirchi launched its own digital platform, Mirchi Plus, available as an app and web experience, offering a vast library of audio, video, and text content, including original audio series, podcasts, RJ videos, and Bollywood news in nine different languages.[8] This focus on customized, hyper-local, and multi-media solutions for advertisers, with an emphasis on tangible results, distinguishes its approach.[8] This strategic pivot is already yielding results, with digital initiatives contributing a notable 12% to Radio City's total revenue.[39]

Red FM has similarly embedded a "digital-first approach" across its operations, encompassing campaigns, intellectual properties (IPs), leveraging RJs as influencers, and on-ground activations.[39] The network has actively grown its podcast ecosystem, surpassing 10 million listens across nine languages, reflecting a commitment to content diversification.[40] Red FM views this evolution as reimagining radio into a "dynamic, phygital experience," seamlessly blending physical events with digital engagement.[40] Their digital initiatives include robust social media

strategies, exemplified by campaigns like #RedRaas, which successfully boosted audience engagement, brand visibility, and user-generated content across Instagram and Facebook.[9, 41] Red FM is also at the forefront of adopting advanced technologies, utilizing AI for streamlined internal processes, enhanced consumer targeting through tools like Demand Gen, Performance Max, and Meta Advantage, and for elevating content creation and curation.[40] Their focus on hyper-local storytelling, particularly in India's Tier 2 and 3 cities, and exploring AR/VR integration in live events, demonstrates a forward-looking strategy that leverages both technology and their core strength in local connection.[40]

The digital strategies of Mirchi and Red FM reveal a significant evolution from merely broadcasting to becoming comprehensive "audio solution providers" and "phygital experiences." This signifies a strategic pivot from a traditional media mindset to a holistic content and marketing ecosystem. This approach allows them to leverage their core strengths—trust, local connection, and talent—in new digital formats, recognizing that simply replicating analog content online is insufficient. They are adapting their business models to the broader digital audio economy, offering integrated solutions that combine their traditional reach with digital precision and interactivity.

Radio's Evolution: From Broadcaster to "Phygital" Powerhouse

This transformation can be visualized as a progression:

1. Traditional Broadcaster:
o Focus on FM transmission, music programming, and selling on-air ad spots.
2. Content Diversification:
o Development of podcasts, original audio series, and digital video content (RJ videos).
3. Phygital Solution Provider:
o Integrated campaigns across FM, digital audio platforms, social media, and live events. Using AI and data for targeting.

This progression highlights how leading radio players are evolving beyond traditional FM, transforming into integrated media companies that blend physical and digital experiences.

However, Indian radio broadcasters face several challenges in this digital shift. They have struggled to keep pace with the rapid advancements of digital streaming platforms and face difficulty attracting advertisers who are increasingly drawn to digital channels.[42] High license fees for private FM stations often restrict content to popular music, limiting diversification.[43, 44] Geographic limitations, with private FM operators typically confined to city-based licensing, also hinder their reach and growth potential.[42] Community radio, while vital, faces additional cultural, technological, economic, and regulatory hurdles, including restrictions from core revenue streams like advertising and corporate sponsorships.[4] Competition from other media sectors for skilled talent further compounds these challenges.[24]

Despite these hurdles, significant opportunities for digital transformation exist in the Indian market. The Telecom Regulatory Authority of India (TRAI) has introduced groundbreaking recommendations, including allowing concurrent online streaming, proposing unified program and advertisement codes, and introducing "Terrestrial Radio Services" for nationwide authorization.[42] These regulatory changes, along with flexibility in adopting analog or digital FM technology, offer a crucial bridge into the digital age.[42] Technologies like HD Radio present further advantages, enabling spectrum efficiency (up to four channels on a single frequency), superior sound quality, multimedia integration (album art, text), emergency alerts, and lower power consumption.[45] Crucially, HD Radio can provide listenership data, a valuable insight for advertisers.[45] Initiatives like "Make in India" can further incentivize domestic radio device manufacturing.[43] Leveraging India's vast mobile phone user base (90 crore reached by Prasar Bharati) represents a substantial asset for digital expansion.[43] Furthermore, radio has shown its capacity to improve the effectiveness of OTT advertising, with a radio + digital mix yielding higher sales uplift than either channel alone.[46, 47]

The regulatory challenges, such as high license fees, geographic limitations, and content restrictions, are significant barriers to the full digital transformation and monetization of Indian radio. TRAI's recommendations and technologies like HD Radio offer crucial pathways to overcome these obstacles. This highlights that policy reform and technological adoption are as critical as internal content innovation for future growth. The immense potential of India's radio market, often described as a "golden goose," implies that unlocking its full potential requires a supportive regulatory and technological environment that fosters, rather than hinders, digital evolution.[43]

VII. Strategic Remedies for Clients and Advertising in an Evolving Landscape

In this evolving audio landscape, clients and advertisers must adopt a multi-faceted strategy that leverages radio's unique strengths while embracing digital synergy and robust measurement.

Leveraging Radio's Trust

Radio's inherent credibility is a powerful asset that should be integrated into multi-channel campaigns. Studies show that radio's trustworthiness makes consumers significantly more likely to trust businesses recommended by AI.[6] Combining radio with digital marketing yields higher sales uplift compared to either channel alone.[47] Radio also demonstrates a tangible impact on digital activity, boosting Google search activity by an average of 29% and Facebook activity by up to 20% for advertised brands.[46] This indicates a synergistic relationship: radio creates awareness and trust through its intimate, human connection, which then translates into online action. Digital platforms, with their

precise targeting and attribution capabilities, can then capture and convert this radio-generated interest. This reframes radio from a standalone advertising channel to a crucial catalyst for digital marketing success.

Radio + Digital: A Powerful Synergy

Campaigns that combine radio with digital advertising demonstrate a significant uplift in key metrics:

Lifts

■ Google Search ■ Facebook Activities ■ Overall Sales Uplift ■
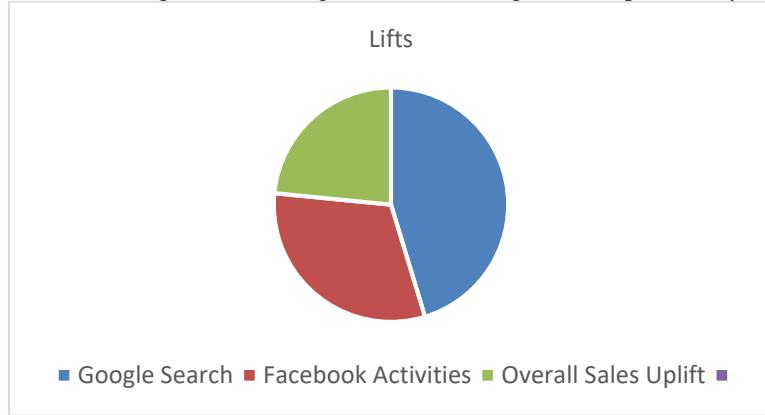
This data illustrates that radio doesn't compete with digital; it amplifies it. Combining radio's trust and reach with digital's precision targeting drives significantly higher results across various campaign objectives.

Emphasizing local relevance and authentic human connection is paramount. Local radio strengthens trust by reflecting listeners' realities.[1] On-air personalities are perceived as trusted friends who understand and care about what matters to their audience.[5] Hyper-local storytelling, particularly in regions like India's Tier 2 and 3 cities, resonates deeply with audiences and can foster strong community bonds.[40]

Optimizing Advertising Effectiveness

To maximize the impact of radio advertising, strategic frequency and timing are essential. Psychological principles suggest that approximately 3.4 impressions per person per week are needed for an advertising message to be memorable, which often translates to around 21 ads per week per station.[14] Advertisers should strategically focus on peak listening times, such as morning and evening commute times, and align ad placements with routine activities where the target audience is most likely to be exposed to radio.[13] Effective "dayparting" ensures ads match specific audience habits and preferences.[13]

Enhancing creative content is crucial to cut through the "inattentive processing" that characterizes much of radio listening.[16] Ads should be designed to engage listeners emotionally, creating vivid mental images through sound.[21] Utilizing professional voice talent, crafting clear and concise calls to action, and focusing on a single, impactful message per spot are vital.[10, 23, 48] Memorable jingles can increase ad retention by 20%.[15] Creativity is key to creating "trace memories"—non-semantic, impressionistic associations (musical, emotional) that stick in the listener's mind even without full conscious attention.[16] Advertisers should avoid common pitfalls such as forced dialogue, cramming too much information, or failing to hook the listener within the first few seconds.[10] The aim should be to engage rather than irritate [16], and shorter ads can be more effective in minimizing annoyance.[12]

Embracing Digital Synergy

Integrating radio with digital marketing is no longer optional but a strategic imperative. Radio serves as a powerful "gateway" for online search, prompting listeners to seek more information about brands they hear on air.[46, 47] A cross-channel approach amplifies reach and reinforces messaging across multiple touchpoints.[48] Combining radio with digital ads can double campaign efficiency, even with a relatively small radio budget allocation (e.g., 11%).[36]

Exploring new monetization models beyond traditional spot advertising is vital for long-term sustainability. This includes sponsored content, premium content offerings, and subscription services.[24, 25] Addressable advertising on Connected TV platforms can command premium rates and drive real results.[25] Leveraging data from new technologies like HD Radio can provide valuable listenership insights, enhancing advertising possibilities.[45] Furthermore, innovating content for digital platforms—such as podcasts, audio series, and RJ videos—and creating "phygital" experiences that blend physical and digital elements are crucial for capturing evolving audience habits.[8, 30, 40, 49]

Measurement and Attribution

Quantifying radio's impact is essential to demonstrate return on investment (ROI). Real-time analytics for on-demand radio and podcasts provide granular data on audience habits.[32] Attribution tools, such as Rumple, can track website traffic increases directly correlated with radio commercial airings.[46] Advertisers should actively compare pre- and post-campaign website traffic, sales figures, and overall ROI to assess effectiveness.[36] While traditional

radio has historically relied on "gut feelings" for success measurement, the integration of digital capabilities demands and enables robust analytics to justify marketing spend.[18, 46]

To truly thrive, radio advertisers must shift from a "broadcast-first" to an "audio-ecosystem" mindset, viewing radio as one powerful component in a multi-channel strategy. This requires investing not just in traditional airtime but in sophisticated creative, digital integration capabilities, and data analytics to prove ROI. The data indicates that advertisers often underestimate radio's actual reach and retention, and there is a perceived gap in digital marketing skills among radio representatives.[17, 22, 50] To maximize effectiveness, advertisers need to understand radio's unique psychological impact (trust, emotional connection, inattentive processing), create ads specifically designed for audio and its ambient influence, integrate these with digital channels for measurable results, and demand better attribution and data from their radio partners. This holistic approach moves beyond simply buying spots to strategically leveraging radio's distinct value within the broader digital audio landscape.

Table 1: Key Recommendations for Radio Advertisers in the Digital Age

Strategy Category	Specific Recommendation	Rationale/Mechanism	Key Snippets	Expected Outcome
Leveraging Trust	Emphasize Local Personalities & Community Focus	Builds emotional bond and authentic connection, making messages more relatable and trusted.	[1, 5, 40]	Increased brand affinity, higher listener loyalty.
Leveraging Trust	Integrate Radio into Multi-Channel Campaigns	Radio's credibility boosts trust in AI-recommended businesses and drives online search/social activity.	[6, 46, 47]	Enhanced digital engagement, higher sales uplift across channels.
Optimizing Ads	Implement Strategic Frequency & Timing	Ensures ads are heard enough times for memorability (avg. 3.4 impressions/week) without causing fatigue.	[13, 14]	Improved ad recall, maximized reach during peak listening.
Optimizing Ads	Enhance Creative Content for "Ambient Influence"	Engages listeners emotionally and creates "trace memories" even during inattentive listening.	[15, 16, 21, 23]	Stronger brand associations, higher ad effectiveness, reduced annoyance.
Optimizing Ads	Focus on Relevance & Value Exchange	Minimizes annoyance by aligning ads with listener interests and providing clear utility or entertainment.	[10, 12, 16]	Greater listener acceptance, positive brand perception.
Embracing Digital	Integrate Radio with Digital Marketing	Radio acts as a "gateway" to online searches and amplifies digital campaign efficiency.	[36, 47, 48]	Seamless consumer journey, amplified digital reach and conversions.
Embracing Digital	Explore New Digital Monetization Models	Diversifies revenue beyond traditional spots; includes sponsored content, premium services, addressable ads.	[24, 25]	New revenue streams, increased financial viability.
Embracing Digital	Innovate Digital-Native Audio Content	Develop podcasts, audio series, and "phygital" experiences to capture evolving listening habits.	[8, 30, 40]	Expanded audience reach, deeper engagement in digital spaces.
Measurement	Utilize Advanced Attribution Tools	Tracks real-time website traffic and other digital actions directly linked to radio ad airings.	[36, 46]	Measurable ROI, data-driven optimization of campaigns.

Conclusion: The Future of Radio's Enduring Influence

Radio's journey through the digital age is not one of decline, but of profound evolution. Its enduring trust, cultivated over a century through human connection, local relevance, and reliability during critical times, remains its most formidable asset.[1, 2] While audience aversion to advertisements is a genuine challenge, the data reveals a nuanced reality: high listener retention during commercial breaks and the pervasive nature of "inattentive processing" offer significant opportunities for advertisers who employ strategic and creative approaches.[16, 22]

The audio landscape has undoubtedly fragmented with the rise of OTT platforms and podcasts, leading to shifts in music consumption habits.[27, 28] However, radio continues to command a dominant share of ad-supported audio listening and serves as a powerful driver for digital engagement, prompting listeners to seek more information online.[34, 35, 46] Leading Indian radio players like Mirchi and Red FM exemplify this adaptability, actively embracing digital transformation by diversifying content, leveraging new technologies like AI, and building "phygital" experiences.[8, 39, 40] Yet, their path forward is not without obstacles, as regulatory hurdles and geographic limitations continue to pose challenges to full digital monetization and reach.[4, 42, 43]

The future of radio is not about choosing between analog and digital, but about achieving a seamless "phygital" coexistence and synergy. This convergence allows radio to leverage its traditional strengths—deep trust, local reach, and authentic human connection—while simultaneously tapping into digital's capabilities for personalization, interactivity, global reach, and new monetization models. [40, 43] Technologies like HD Radio, which facilitate multi-channel broadcasting and provide listenership data, alongside supportive policy reforms from bodies like TRAI, are crucial enablers for this integrated future. [42, 45]

Ultimately, radio is not merely surviving; it is reinventing itself. Its sustained relevance and growth will hinge on its ability to continue adapting to new consumption patterns while reinforcing its unique identity as a trusted, human-centric medium. For advertisers, this means recognizing radio as a vital component within a broader audio ecosystem, capable of amplifying digital campaigns and delivering measurable results through intelligent creative, precise timing, and robust attribution strategies. By embracing this integrated "phygital" approach, radio is well-positioned to maintain its enduring influence in the dynamic media landscape.

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Original Article

Cognizance of renewable energy laws and policies in India: Harnessing energy share with SAARC nations

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Abstract

The paper explores the evolution and current framework of renewable energy laws and policies in India, emphasizing its leadership role among SAARC nations. It highlights India's constitutional and legislative foundations that empower both central and state governments to promote renewable energy. Key enactments such as the Electricity Act, 2003; Energy Conservation Act, 2001; and subsequent policies like the National Electricity Policy (2005) and various landmark schemes have strengthened India's clean energy transition. The study also examines India's initiatives in cross-border energy sharing with SAARC nations through regulatory frameworks such as the Central Electricity Regulatory Commission (Cross Border Trade of Electricity) Regulations, 2019, and the establishment of the SAARC Energy Centre. It concludes that achieving 100% renewable energy in the SAARC region is feasible with strong collaboration, financial investment, and harmonized policies across member countries.

Keywords: Renewable Energy, Energy Laws, Electricity Act 2003, Energy Conservation Act, National Electricity Policy, Green Energy, SAARC Energy Centre, Cross Border Energy Trade, Sustainable Development, Climate Change, India, Renewable Policies.

Introduction:

"Energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive"- Ban Ki-moon. Energy is an inevitable part of human life. Whole of the society would crumble in the hypothetical case of energy deficiency. Rapid industrialization and multifold growth of population have prompted the raising demand for energy. To meet the economic targets, countries resorted to optimal use of conventional energy sources at the cost of Environmental damage. The adverse effects on Environment were evident through Global warming, acid precipitation, and ozone depletion. It was realized later that there should be a balance between development and environmental protection. Experts recommended for switching to renewable energy and other alternate forms of clean energy which every country gradually started to adopt. Over a decade renewable energy generation has seen an unprecedented acceleration. It is estimated that the renewable power capacity increased an estimated 36% in 2023 to reach around 473 GWs which is a new record over 22nd consecutive year. Along with Solar PV accounted for three- quarters of all the renewable power capacity additions in 2023. Particularly India has remained a greatest contributor to renewable energy generation across the world and a leader among SAARC nations. India has increased clean power by 40% over the past five years, though the reliance on fossil fuels in the power sector has also increased significantly. The Ministry of New and Renewable Energy (MNRE) has reported robust progress in India's clean energy sector for the Financial Year 2024–25. With a record annual capacity addition of 29.52 GW, the total installed renewable energy

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(RE) capacity in the country has reached 220.10 GW as of 31st March 2025, up from 198.75 GW in the previous fiscal. India is a forerunner in International renewable energy lobby and has been a pioneer in establishing International Solar Alliance in 2015. SAARC is a conglomeration of South Asian countries comprising of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. All the above countries are geographically advantageous of being situated around tropical region. They receive considerable solar energy throughout the year and few of the countries have favourable tidal energy sources from sea. In the view of energy sharing across borders, SAARC Energy Centre was formed for the purpose of converting energy challenges into opportunities for development of SAARC Region. This paper gives an overview of laws and policies advancing renewable energy and its sharing across the borders.

Renewable energy laws and policies in India:

Constitution of India is the foundational document for any regulatory framework within the territory of India. It is the basic source from which other laws emanate. Any laws and policies framed shall be in accordance and not derogatory with the provisions of Indian Constitution. Electricity as a legislative subject matter finds it's place in concurrent list, which means that both Centre and State Governments are empowered to legislate on and matters incidental thereto. Entry 33 of List III relates to trade and commerce in and the production, supply, and distribution of the products of any industry where the control of such industry by the Union is declared by Parliament by law to be expedient in public interest and supply and distribution includes the power to control the price of the commodities coming under this entry. As we see that renewable energy has not been specifically mentioned in the seventh schedule so as per the scheme provided under Article 248 read with Entry 97, List I of Seventh Schedule of the Indian Constitution the residuary power of legislation has been given to the Parliament where it can legislate on those matters which are not mentioned in the Concurrent List or State List and can impose tax on such matters which are not mentioned in any of these lists. For the first time renewable energy got its place in the Eleventh Schedule of the Indian Constitution through the 73rd amendment Act which added Panchayats as a local self-Government, where non-conventional energy resources were included.

Government of India has so far enacted the following laws and policies promoting renewable energy:

1. **Electricity Act, 2003:**
   This is the comprehensive legislation enacted for consolidating the law relating to generation, transmission, distribution, trading and use of electricity. This Act ensures framing transparent policies regarding renewable energy and constitution of Central Electricity Authority, Regulatory Commissions and appellate Tribunal. Section 4 of the Act empowers Central Government in consultation with State Government to notify national policy, permitting standalone systems including renewable sources of energy and other non-conventional sources of energy. Section 61 of this Act empowers Appropriate Commission to specify terms and conditions for the determination of tariff and while doing so shall consider the promotion of co-generation and generation of electricity from renewable sources of energy. Section 86 of the Act directs State Commissions to promote co-generation and generation of electricity from renewable sources of energy. In the exercise of powers conferred by Section 176 of the Electricity Act, 2003 Central Government has enacted Electricity Rules, 2005 in accordance with the above enabling Act.

2. **Electricity (Promoting Renewable Energy through Green Energy Open Access) Rules, 2022:**
   The above rule is enacted by the enabling provision of the Electricity Act, 2003; Section 176(2). Renewable Purchase Obligation and Green Energy open access were introduced through this rule. It obligates the distribution licensee and trading licensee to procure renewable energy from generator or captive generation.

3. **Central Electricity Regulatory Commission (Terms and Conditions for Tariff Determination from Renewable Energy Sources) Regulations, 2020:**
   These regulations apply to cases where tariff for a grid connected generating station based on renewable energy sources. It enumerates tariff structure, tariff design, treatment for over generation, capital cost and subsidy.

4. **Central Electricity Regulatory Commission (Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation) Regulations, 2022:**
   It provides for issuance of certificates for renewable energy, grant of accreditation for certificates, revocation of accreditation, and exemption as well as redemption of Certificates.

5. **Energy Conservation Act, 2001:**
   This Act provides for the efficient use of energy and its conservation and for the matters connected with it. This Act defines "energy conservation and sustainable building codes" as codes which provides norms and standards for energy efficiency and its conservation, use of renewable energy and other green building requirements for a building. Section 4 of this Act prescribes that the management of Bureau of Energy Efficiency includes Managing Director of the Indian Renewable Energy Development Agency Limited.

6. **National Electricity Policy, 2005:**
   Section 3(3) of the Electricity Act, 2005 enable Central Government to prepare National Electricity Policy time to time in consultation with State Governments. National Electricity Policy aims at achieving the following objectives

access to electricity, availability of power, supply of reliable and quality power, per capita availability of electricity and protection of consumers.

Landmark Schemes:

1. **National Action Plan on Climate Change (NAPCC)** - Aims to combat climate change in pursuance of which renewable energy targets were set. It includes National Solar Mission and National Wind Energy Mission in enhancing renewable energy.

2. **Scheme for Development of Solar Parks and Ultra-mega Solar Power Projects** was formed with a target of setting up 40,000 MW capacity. The scheme helps expeditious development of utility-scale solar projects in the country.

3. **Production Linked Incentive scheme 'National Programme on High Efficiency Solar PV Modules** aims at achieving manufacturing capacity of Giga Watt (GW) scale in High Efficiency Solar PV modules.

4. **PM-KUSUM Scheme-** aims at promoting small Grid Connected Solar Energy Power Plants, stand-alone solar powered agricultural pumps and solarisation of existing grid connected agricultural pumps. States can save on subsidy provided for electricity to farmers and DISCOMs.

5. **Rooftop Solar Programme**- Under this Programme, is given for housing and performance linked incentives to DISCOMs for achieving capacity addition in rooftop solar target.

6. **Green Energy Corridors (GEC):** to enhance intra-state transmission infrastructure system for renewable energy projects.

7. **National Bio-Energy Programme:** This Programme aims at deriving Energy from Urban, industrial and Agricultural Wastes or Residues.

8. **National Green Hydrogen mission:** Aims in production, utilization and export of Green Hydrogen and its derivatives.

9. **Pradhan Mantri Surya Ghar yojana-** This scheme aims to provide free electricity with the help of solar panels implementation on the rooftops.

India and SAARC- cross border renewable energy sharing:

India's renewable energy zones are not linear and remain sporadic. This can be classified as various renewable energy zones such as wind, solar, hydroelectric and tidal. India's national renewable energy zones for wind power and solar photovoltaics (PV) could become regional green power resources among SAARC nations if only they liberalize their rules for cross-border energy trading (CBET). For majority of SAARC nations combining domestic renewable energy with imported wind, PV, and hydropower could accelerate decarbonization and reduce generation costs. Let us study India law and policies focusing on cross border energy trade with SAARC:

Central Electricity Regulatory Commission (Cross Border Trade of Electricity) Regulations, 2019:

This Act is enacted with the object of cross border trade with India and neighboring countries. It mainly concentrates on tariff determination, trading through power exchanges, cross border transmission link, application to open access, total transfer capability, Available transfer capability, transmission losses and dispute settlement and resolution mechanism.

SAARC energy centre:

SAARC energy centre was formed in 2005 to resort the energy challenges in the region by promoting renewable and alternate energy as well as agreement to cross border trading of renewable energy.

MoU between SAARC and IRENA:

On January 11, 2025 both the above associations signed a collaborative framework to harness the optimal sustainable use of all forms of renewable energy across the South Asian region. This attempt tries to unlock full potential of renewable energy across SAARC nations.

Conclusion:

Study shows that 100% renewable energy or net zero emission could be a reality in the SAARC region with cross border sharing of renewable energy. This could be possible with stricter environmental policies facilitating sustainable energy transition. SAARC Energy Centre is playing a vital role in enhancing energy integration among South Asian Region to achieve overall economic growth. Cross Border Trade of Energy will also help in addressing climate change and achieving Sustainable Development Goal of United Nations. The foremost challenge in establishing Renewable energy sharing across countries are financial capital for infrastructure. A fair, transparent, and competitive pricing framework is essential for growth and to attract investment in the renewable power sector. This could be practicable by stakeholders such as Government, national regulators and private players for establishing a competitive sustainable energy marks and power pricing mechanism in the region. In a nutshell for bolstering cross border energy trade across South Asia Region, it is required to overcome challenges like harmonization of policies or regulations,

harmonization of grid codes, reforms and restructuring of institutions dealing with renewable energy, establishing trust and relationship between countries.

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Original Article

Library Automations: Issues, Challenges, and Remedies in Engineering Colleges, Pune Region, Maharashtra

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Abstract

Library automation has become an indispensable strategy for enhancing the efficiency and quality of academic resource management, particularly in engineering colleges where timely access to technical literature is essential. This paper identifies and analyses the barriers to implementing Integrated Library Management Systems (ILMS) in engineering colleges across the Pune Division of Maharashtra and proposes practical solutions through a comparative framework. Using a mixed-methods research approach including surveys, interviews, and case studies validated through pilot testing, the findings indicate that open-source platforms such as KOHA offer significant cost advantages. In contrast, proprietary software solutions like SLIM and AUTOLIB tend to be more technically demanding, although they often provide stronger support services and better scalability. The study concludes by outlining a regionally relevant implementation model, with emphasis on systematic user training, careful data migration planning, and future integration of AI-enabled ILMS functionalities to enhance library services and user experience.

Keywords: Library automation, Integrated Library Management Systems, Open-source Software, Proprietary Software.

Introduction

Libraries serve as the intellectual backbone of engineering colleges, acting as vital hubs for knowledge dissemination, innovation support, and the promotion of scholarly growth among students and faculty. In an era characterized by the exponential expansion of technical literature and rapid advancements in digital learning environments, the role of academic libraries is undergoing marked transformation. Traditional manual systems, once adequate for cataloguing and circulation, now exhibit significant limitations, particularly in managing large and diverse collections, enabling remote access, and ensuring efficient utilization of resources.

Integrated Library Management Systems (ILMS) represent a pivotal advancement in library automation, offering improved operational efficiency, enhanced user experience, and systematic data management. By automating core library functions such as cataloguing, acquisition, circulation, and digital resource integration, ILMS facilitates streamlined workflows and more effective service delivery. In engineering colleges, where timely access to current and specialized technical information is essential, the adoption of ILMS is not merely a technological enhancement it has become a strategic imperative for academic competitiveness and institutional excellence. However, the transition to automated library systems presents a range of challenges. The Pune Division of Maharashtra comprises a diverse mix of engineering colleges including government, private, aided, and autonomous institutions that often operate under financial constraints and possess varied levels of infrastructural readiness. Technical challenges such as insufficient IT support, resistance to technological change among library staff, and the complexity of migrating legacy data can further impede successful ILMS

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implementation. Additionally, limited opportunities for professional development and training restrict librarians' ability to harness the full potential of automated systems, thereby affecting overall system efficiency and user satisfaction.

While existing literature offers numerous examples of successful ILMS adoption in large, well-resourced institutions globally, there remains a notable gap in region-specific research focusing on smaller and mid-sized engineering colleges in contexts such as the Pune Division. The unique convergence of financial, technical, and human resource limitations in these institutions necessitates tailored strategies and context-sensitive implementation frameworks. Addressing these research gaps, the present study undertakes a systematic examination of the key challenges, implementation barriers, and possible solutions associated with library automation in engineering colleges across the Pune Division.

Definition of Library Automation:

According to the Encyclopaedia of Library and Information Sciences, "Library Automation is the use of automatic and semiautomatic data processing machines to perform such traditional library activities as acquisitions, cataloguing, and circulation. These activities are not necessarily performed in traditional ways, the activities themselves are those traditionally associated with libraries; library automation may thus be distinguished from related fields such as information retrieval, automatic indexing and abstracting and automatic textual analysis". Also, "automation is the technology concerned with the design and development of process and system that minimize the necessity of human intervention in operation" (Kent, 1977).

According to Dictionary for Library and Information Science, library automation is "the design and implementation of ever more sophisticated computer systems to accomplish tasks originally done by hand in libraries" (Reitz, 2004)

This paper aims to:

- Analyze barriers to ILMS adoption specific to Pune division engineering education sector
- Compare the merits and limitations of open-source and proprietary automation platforms
- Propose an actionable and scalable framework for overcoming challenges, emphasizing training, infrastructure investment, and future-ready technologies Through comprehensive literature synthesis, empirical data collection, and the development of a tailored implementation model, this research seeks to guide policymakers, librarians, and administrators in making informed strategic decisions for library automation.

Literature Review:

Pernaa, J. and others (2023) in this research paper emphasizes the significance of open-source technology in advancing cheminformatics by providing affordable and accessible software solutions. It highlights how open-source tools enhance education through interdisciplinary learning and promote open science practices. The study suggests that such software supports curriculum development, fosters research-based learning, and strengthens computational skills among chemists. Moreover, understanding open-source development encourages collaboration and innovation in scientific research. The paper concludes that computer literacy is essential in modern chemistry, as proficiency in software tools improves data analysis, hypothesis testing, and overall research efficiency, contributing to the progress of cheminformatics education and practice.

Suleman, Muhammad and others (2022) in their research paper "prospect and challenges for library automation in academic institutions" present prime objective, appropriate information, increasing users and shortages of financial resources. Due to these problems, resources can be used in the network. New technology can adapt and provide services, by using circulation, cataloguing, acquisition and management modules. Needs of customer satisfaction, growth of literature. Defining of library budget. Increasing cost of documents and technical advancement.

Vassiliadas, Panos (2021) in his research paper evaluation in free open source software, author present finding 195 free open source software projects evaluation of schema. Attribute, tables and deleted or renamed otherwise data key altered mines a schema evaluation. It is a deep study of maintenance and sharp software evaluation. In this similarities, patterns and reducing behaviour of the software. Schema evaluation understanding mechanics of pieces and knowledge, like data engineering community. Software Schema software ability and benefits are development are scientific and practical side. The academic community can use data models and underwrite the sustainability, as well as deeper use of the education students.

Singh and Sharma (2020) presenting in their research paper substantial body of research endorses the adoption of open-source ILMS platforms such as KOHA, NewGenLib, and Evergreen, citing economic viability, adaptability, and strong community support as key benefits. illustrate that these systems empower smaller institutions to tailor functionalities without incurring significant licensing fees. However, notable constraints persist: successful deployment requires sustained investment in technical skills, and troubleshooting often relies on community-driven forums, which can delay timely resolution for critical issues.

Kumar and Reddy (2013) present in the research paper proprietary ILMS solutions like Symphony and Alma are recognized for their comprehensive vendor support, frequent updates, and polished user interfaces. Research by highlights their effectiveness in facilitating rapid adoption and ensuring system reliability for large institutions with

substantial budgets. Nonetheless, the literature also warns of recurring costs, risks of vendor lock-in, and constrained customizability, factors that render these options less feasible for resource-constrained engineering colleges.

Biswas, Rounak (2020) With the rapid growth of technology, libraries are increasingly adopting digital solutions to enhance their operations. The introduction of computers has transformed traditional manual processes into automated systems, improving efficiency in cataloguing, acquisition, circulation, and serial control. This transformation, known as library automation, is achieved through the use of Integrated Library Management Systems (LMS), which streamline all housekeeping tasks with a single data entry. LMS functions like an enterprise resource planning tool for libraries. In recent years, open-source library management software has gained popularity among professionals due to its affordability, flexibility, and ease of customization compared to commercial systems.

Bwalya, T. (2019) The study discusses the role of Free and Open-Source Software (FOSS) in promoting accessible and modifiable software for library management. It focuses on OpenBiblio, an open-source integrated library system ideal for small institutions due to its easy installation and compatibility with Windows and Linux. Despite its compliance with major standards like Z39.50 and MARC 21, the paper notes that limited online documentation poses challenges for beginners. It also highlights sustainability concerns, as OpenBiblio's development community has become less active. The research recommends assessing long-term viability before adoption to ensure continued support and effective library automation.

Patel and Mehta (2018) author suggest that small and mid-sized colleges must develop stepwise approaches integrating, on local context and stakeholder engagement to ensure sustained success. The literature also addresses technical challenges of data migration from legacy systems, emphasizing the need for meticulous planning and comprehensive backup procedures. In the Indian academic settings, issues, challenges such as language localization, IT literacy gaps, and region-specific acquisition policies further complicate automation efforts.

Pandya, D M and Darbar, M (2016) in their research paper namely user perception on library automation, present the use of ICT in after different library automation their strategy, computerized activities, thinking, and service provider will be totally changed. Proper information to right user in right time providing is possible after the library automation.

Uzomba, E C and others (2015) present paper "Use and application of open source integrated library system in academic libraries. The study explores the use and application of open source integrated library systems in academic libraries in Nigeria, using Koha as a case study. It highlights the importance of selecting the right library software and the need for technical support in the absence of a vendor. The study suggests that libraries should form consortia to discuss challenges and solutions related to the software. Additionally, it emphasizes the importance of employing an adequate number of library staff with appropriate computer skills to meet the challenges of providing services to users

Wang, Y., & Dawes, T. A. (2012) present paper "The next generation ILS", study identifies a lack of research on next-generation Integrated Library Systems (ILS) and their practical use. Referencing Marshall Breeding's work, it emphasizes the need for better automation tools to assist librarians and enhance user experience. Breeding highlights issues with outdated ILS interfaces and poor electronic content management. He also notes three key trends: digital expansion, evolving user expectations, and improved resource discovery. Overall, the review stresses the need for innovative, user-friendly ILS solutions in modern libraries.

Research Gap and Problem Statement

Over the past decade, the modernization of academic libraries has accelerated globally, with an increasing trend towards the implementation of Integrated Library Management Systems (ILMS) in higher education institutions. Numerous investigations have examined the comparative merits of open-source and proprietary ILMS, the impact of automation on operational efficiency, and user satisfaction in technologically advanced universities. However, the majority of these studies are grounded in large, well-resourced institutions or are conducted in international contexts, where access to funding, technical support, and policy guidance are significantly greater than in many regional engineering colleges.

In India, the existing body of literature acknowledges the potential of library automation to revolutionize academic resource management, yet very few empirical studies focus specifically on engineering colleges located within regional divisions such as Pune, Maharashtra. The distinctive challenges encountered by these colleges including budgetary limitations, infrastructure inadequacies, and high staff turnover often go unaddressed in national and international automation frameworks. Most published research explores generic barriers to adoption, without offering actionable recommendations tailored to the unique environment of smaller academic institutions.

"What are the principal challenges impeding the adoption of Integrated Library Management Systems in engineering colleges of Pune Division, and which context-specific remedies and implementation frameworks can effectively support successful automation?"

By focusing on this research gap, the study aims to contribute regionally relevant insights, comparative analyses, and practical solutions for engineering college administrators and policymakers. The objectives are two-fold: (a) to document and analyze the complex interplay of financial, technical, and human factors influencing automation efforts, and (b) to propose a detailed, scalable roadmap for overcoming barriers and achieving sustainable library modernization in Pune Division.

Aim and Scope

The principal aim of this study is to provide an in-depth analysis of the challenges associated with the adoption of Integrated Library Management Systems (ILMS) in engineering colleges situated within Pune Division, Maharashtra. By addressing the spectrum of technical, financial, and human resource barriers, the research seeks to advance both theoretical understanding and practical guidance for institutions navigating the automation process.

Specific Aims:

- To systematically identify and evaluate the major obstacles such as funding limitations, lack of technical expertise, infrastructural shortfalls, and resistance to change impacting ILMS implementation in engineering colleges.
- To conduct a robust comparative analysis of open-source ILMS platforms KOHA versus proprietary systems AUTOLIB, SLIM and VIDYASAGAR highlighting relative strengths, weaknesses, and suitability for different institutional contexts.
- To document college experiences and user perceptions through quantitative surveys and qualitative interviews, thus grounding recommendations.

Scope:

This research is geographically scoped to the engineering colleges within Pune Division, encompassing public, private, and autonomous institutions. The analysis focuses on the full ILMS lifecycle, from initial needs assessment and system selection to pilot implementation, staff training, data migration, and ongoing evaluation. Limitations of the study include the sample size and regional focus, but findings are expected to be highly relevant for similar academic settings in India and other emerging regions.

By clearly delineating its aims and scope, this research intends to furnish actionable insights and evidence-based strategies for administrators, librarians, and policymakers seeking to overcome the persistent barriers to effective library automation.

Synthesis:

While scholarly consensus affirms the strategic value of ILMS in academic libraries, existing frameworks and best practices often fail to account for the unique mix of technical, financial, and human factors present in regional engineering colleges, particularly within Pune Division. This literature review reinforces the need for targeted, context-driven research and solution design.

Research Methodology

A methodologically robust approach was adopted to examine the adoption and implementation of Integrated Library Management Systems (ILMS) in engineering colleges across Pune Division, Maharashtra. By combining quantitative and qualitative techniques, this study ensures both broad coverage and deep contextual understanding.

Research Design

This investigation employed a concurrent mixed-methods framework. Quantitative data was gathered through structured surveys, while qualitative insights were obtained via semi-structured interviews and institutional case studies. This design enabled the triangulation of findings, increasing the reliability and relevance of results. Sample Selection.

A stratified random sampling strategy was utilized to select 95 engineering colleges, reflecting a blend of public, private, and autonomous institutions within Pune Division. Key informants included library administrators, IT staff, and teaching faculty. Efforts were made to ensure demographic diversity in terms of college size, urban/rural setting, and resource availability.

Limitations

While the methodology ensures strong internal validity, limitations include moderate sample size and geographic focus. Results may not be directly generalizable to colleges outside Pune Division or to other academic disciplines. Future research should aim to expand the sampling region and consider longitudinal study designs.

Comparative Analysis of ILMS Solutions

The decision to adopt a suitable Integrated Library Management System (ILMS) is central to the modernization of engineering college libraries. This section presents a structured comparison of leading open-source and proprietary ILMS platforms, using both literature evidence and empirical results from the surveyed colleges in Pune Division.

Name of the software, types and percentages used for automation in engineering colleges.

No.	Name of Software	No. of Libraries	Type of software	Country of origin	Percentages
1	Koha	31	Open source	New Zealand	32.98
2	Auto Lib	17	Proprietary	India	18.19
3	Slim	12	Proprietary	India	12.77
4	Vidyasagar	6	Proprietary	India	6.38
5	ERP	5	Proprietary	India	5.32
6	Lib Man	5	Proprietary	India	5.32
7	iSLIM	4	Proprietary	India	4.26
8	In-house/other	4	Proprietary	India	4.26
9	Librarian	2	Proprietary	India	2.13
10	Purna	2	Proprietary	India	2.13
11	Eklavya	1	Proprietary	India	2.13
12	LibSoft	1	Proprietary	India	1.06
13	e-Granthalaya	1	Proprietary	India	1.06
14	Smart School	1	Proprietary	India	1.06
15	Biyani (eVidya)	1	Proprietary	India	1.06
16	Vmedulife	1	Proprietary	India	1.06
	Total	**94**			**100**
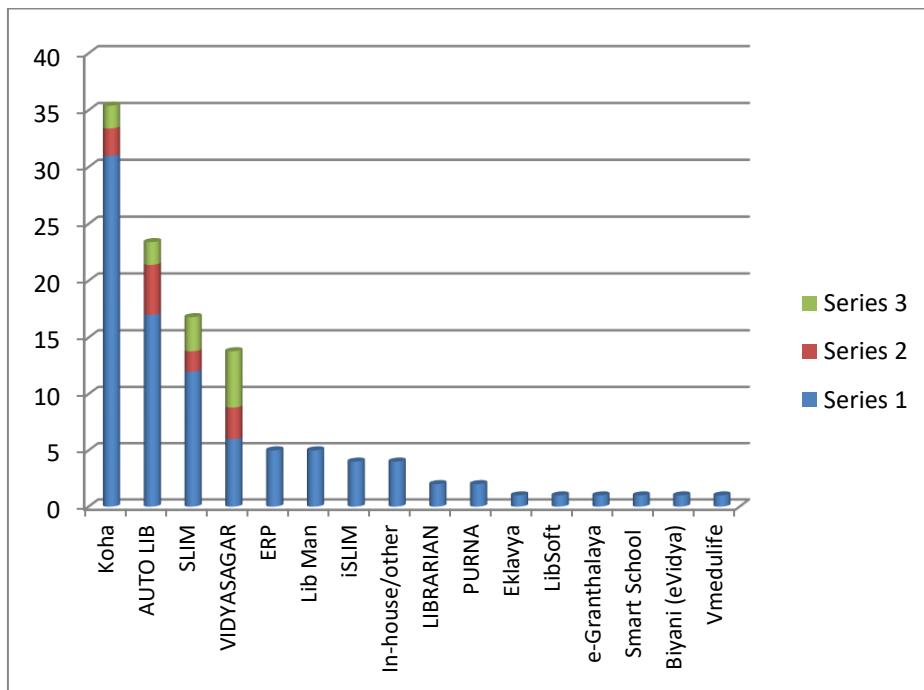
As per observed that, the software type, location of origin, and number of libraries using each system are highlighted in this table, which offers a thorough overview of the library automation software utilised by various institutions. With 31 libraries using it, Koha is by far the most popular program, accounting for 32.98% of all responses. This New Zealand-based open-source program is especially well-liked for its affordability and adaptability. The second most prevalent option is AUTO LIB, an Indian proprietary program that is utilised by 17 libraries, or 18.19 percent of the total. Next, 12 libraries, or 12.77% of the total, use SLIM. Five libraries, or 5.32 percent of the total, use other proprietary systems such Lib Man, ERP, and VIDYASAGAR. Four to two libraries, or 4.26% to 2.13% each, use iSLIM, In-house/other, LIBRARIAN, and PURNA. Only one library, or 1.06% of the total, uses several other proprietary systems, such as Eklavya, LibSoft, e-Granthalaya, Smart School, Biyani (eVidya), and Vmedulife. The data unequivocally demonstrates that, despite the dominance of Indian proprietary systems, Koha continues to be the top open-source choice, chosen by numerous institutions due to its cost and adaptability.

What other features guided you for actual choice of migration.

Sr. No	What other features guided you for actual choice of migration ?	Response	Percentage
1	Cost saving	36	20.33
2	Better system	33	18.64
3	Administrative ease	27	15.25
4	Library Survey	25	14.12
5	Financial reasons	24	13.55
6	Vendor recommendations	16	9.03
7	Market analysis	16	9.03
	Total	**177**	**100**
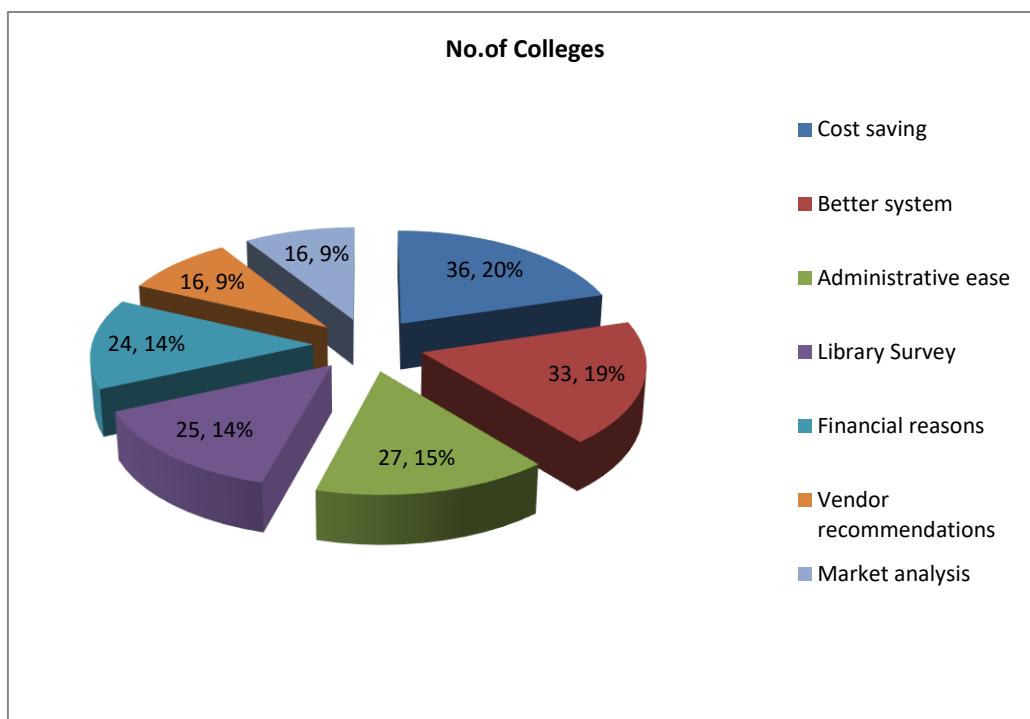
The analysis employs the following evaluation dimensions, deemed essential from both scholarship and institutional feedback:

- Cost (setup, licensing, maintenance)
- Customization
- Training and Documentation
- Technical Support
- Scalability
- Data Migration
- User Experience
- Implementation Time

The comparative analysis underscores that:

- **Open-source ILMSs (KOHA):** Offer budgetary advantages and unparalleled customization but necessitate investment in local capacity-building, staff training, and gradual onboarding.
- **Proprietary ILMSs (AUTOLIB, SLIM and VIDYASAGAR)** Facilitate swift implementation and maintenance, yet pose sustainability challenges for smaller colleges due to recurring costs and less autonomy over system modifications.

  These findings form the basis for targeted recommendations in the next section, supporting context-driven decision making for library automation in Pune's engineering education sector.

Barriers to Implementation

Several recurring challenges were identified across both open-source and proprietary deployments:

- **Technical Skill Gaps:** A majority of respondents reported insufficient in-house technical expertise as the primary barrier to effective implementation and ongoing maintenance.
- **Staff Resistance and Training Needs:** Over half of the institutions cited staff hesitation to transition from familiar manual operations, attributing this to inadequate training opportunities and fear of technological change.
- **Financial Constraints:** Even with open-source adoption, hidden costs emerged around hardware upgrades, network improvements, and periodic technical consultancy.
- **Data Migration Difficulties:** Both survey and interviews consistently highlighted data migration from legacy catalogues as laborious, with risks of data loss or fragmentation.

Critical Success Factors

Institutions that reported successful ILMS implementation shared several key characteristics:

- **Proactive, Continuous Training:** Colleges that invested in comprehensive, ongoing training (including vendor workshops, peer-to-peer sessions, and access to online resources) demonstrated smoother transitions and higher user satisfaction.
- **Leadership and Stakeholder Involvement:** Projects led by engaged administrators and implemented with strong faculty and librarian involvement encountered less resistance and delivered better long-term outcomes.
- **Pilot Testing and Incremental Rollout:** Phased pilot deployments and iterative feedback loops facilitated adaptation and minimized disruption.

User Experience and Outcomes

Analysis of user feedback indicated marked improvements post-automation: cataloguing efficiency increased, user satisfaction with search functions improved, and administrative workload decreased in all cases, although the extent of gains correlated with the quality of training provided and the stability of IT infrastructure. Proprietary ILMS users reported higher satisfaction with technical support and lower rates of system downtime; open-source users valued the ability to adapt their systems to evolving needs, despite facing periodic delays in troubleshooting and upgrades.

Conclusion and Future Scope

This study has provided a holistic analysis of the issues, challenges, and remedies related to the adoption of Integrated Library Management Systems (ILMS) in engineering colleges across Pune Division, Maharashtra. Through a mixed-methods investigation—combining comparative literature review, empirical survey, interviews, and case studies—the research identified that institutional success in library automation hinges upon both technological selection and organizational readiness.

Key findings underscore that open-source ILMS platforms, notably Koha present strong opportunities for budget-conscious colleges, offering extensive customization and community resources. However, successful deployment requires deliberate investments in staff training, IT infrastructure, and change management. Proprietary AUTOLIB, SLIM and VIDYASAGAR ILMS, though attractive for their ease of support and seamless integration, are less accessible to smaller colleges due to financial constraints and the risks associated with vendor dependence.

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